



USING MOBILE ANALYTICS TO IMPROVE TESTING AND DEVELOPMENT PRACTICE

Presented by Julian Harty

Updated: 26 Oct 2016





THE BIG PICTURE

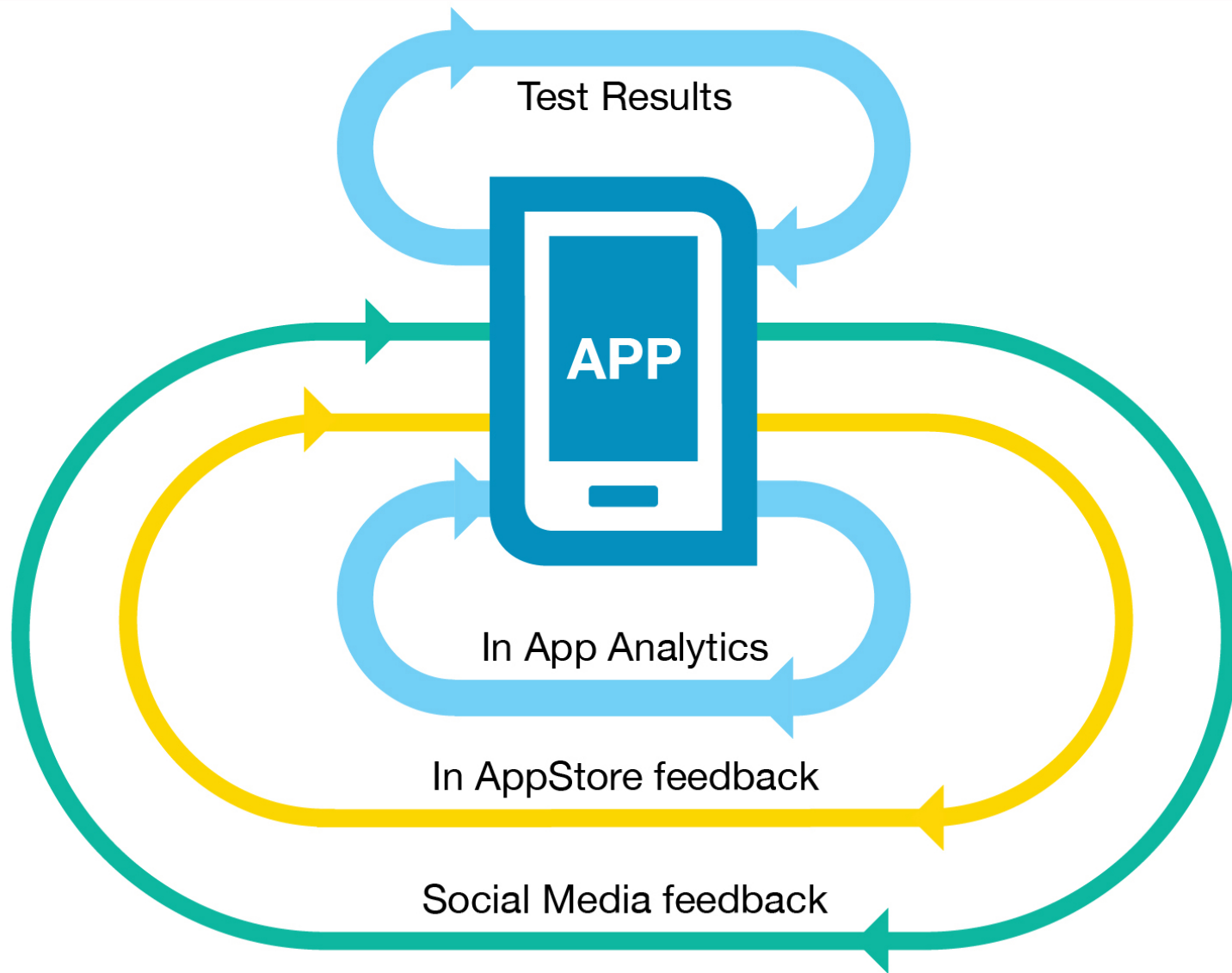
An overview

Provocative statements

- ☐ Are we trying to do better than today?
- ☐ Are we aiming for perfection (zero failures)
- ☐ Are we aiming for “good enough”
- ☐ Do we limit ourselves to what we “know”

The choices lead to very different outcomes/decisions

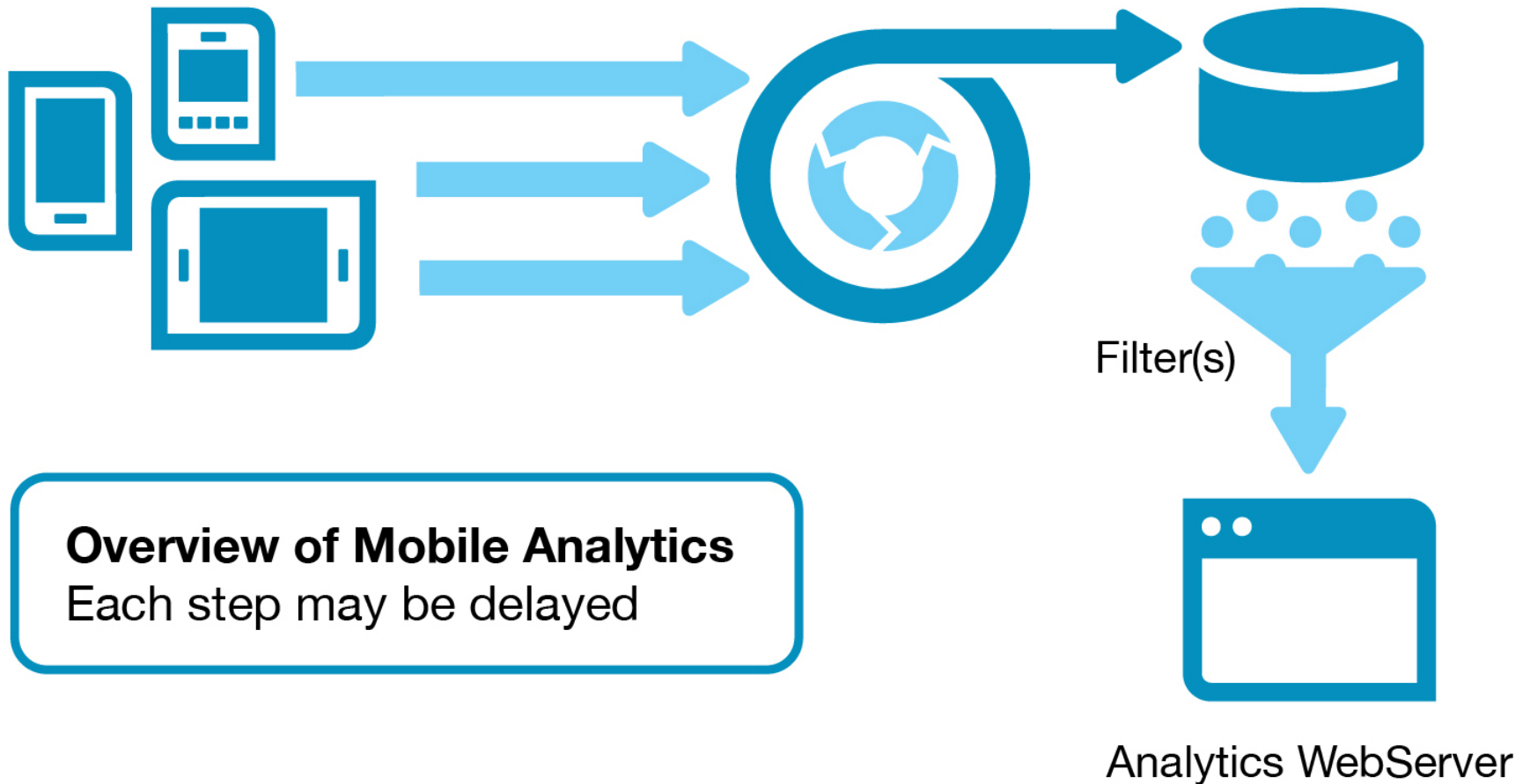
Feedback Cycles



Mobile Apps sending
Analytics data

Data Collector

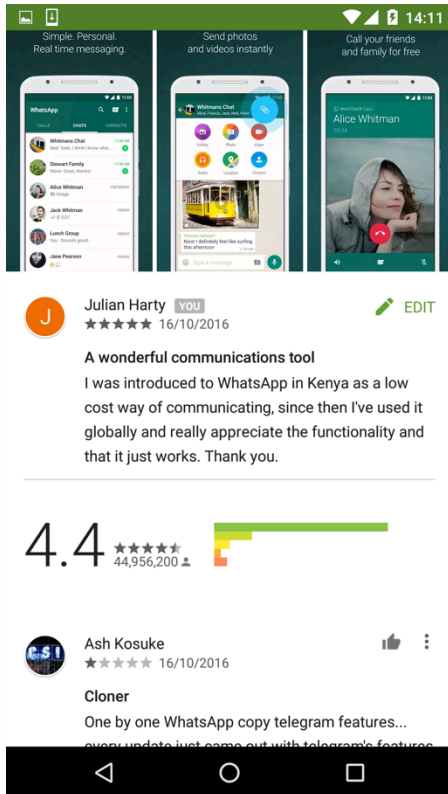
Database



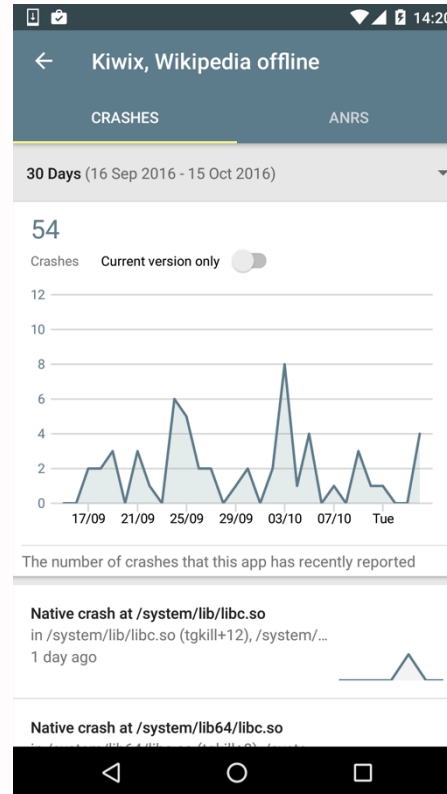
General ways to improve testing of mobile apps

1. Better testing [techniques]
2. Test automation
3. Scaling testing
4. Static analysis of source code and binaries.

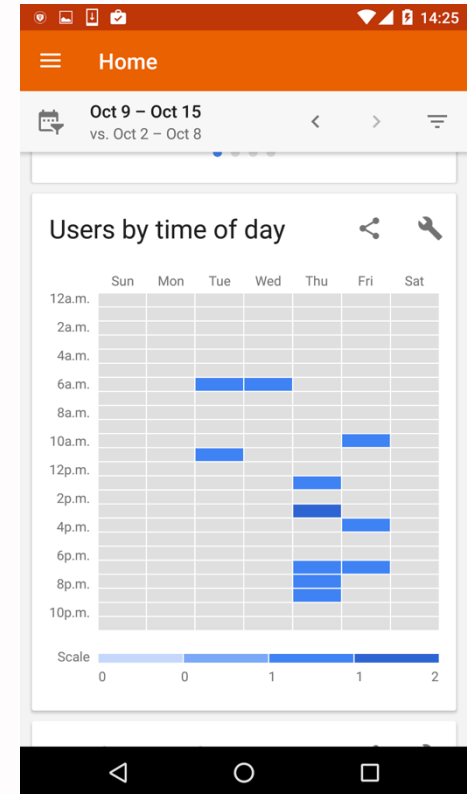
Additional sources of data for mobile apps



Mining ratings & reviews
in mobile app stores



Mining crash analytics



Using in-app
mobile analytics

))) Digital

- Software generated
- Consistent
- Ubiquitous
- Dry
- Machine oriented

))) Analogue

- People generated
- Variable
- Sparse
- Rich
- Emotional
- Human oriented



MOBILE ANALYTICS

Testing using Mobile Analytics

Testing based on analytics data

Testing based on information

- Popularity & volumes
- Locales
- User-flows, activities, etc.
- Crashes

Aims include

- Fast reproduction
- 1st-hand learning in controlled env.

Testing based on insights

- Delta's (rate of change)
- Crossing thresholds
- Anomalies

Aims include:

- Maximising insights, agility, and ability to adapt & respond

Some benefits of analytics data

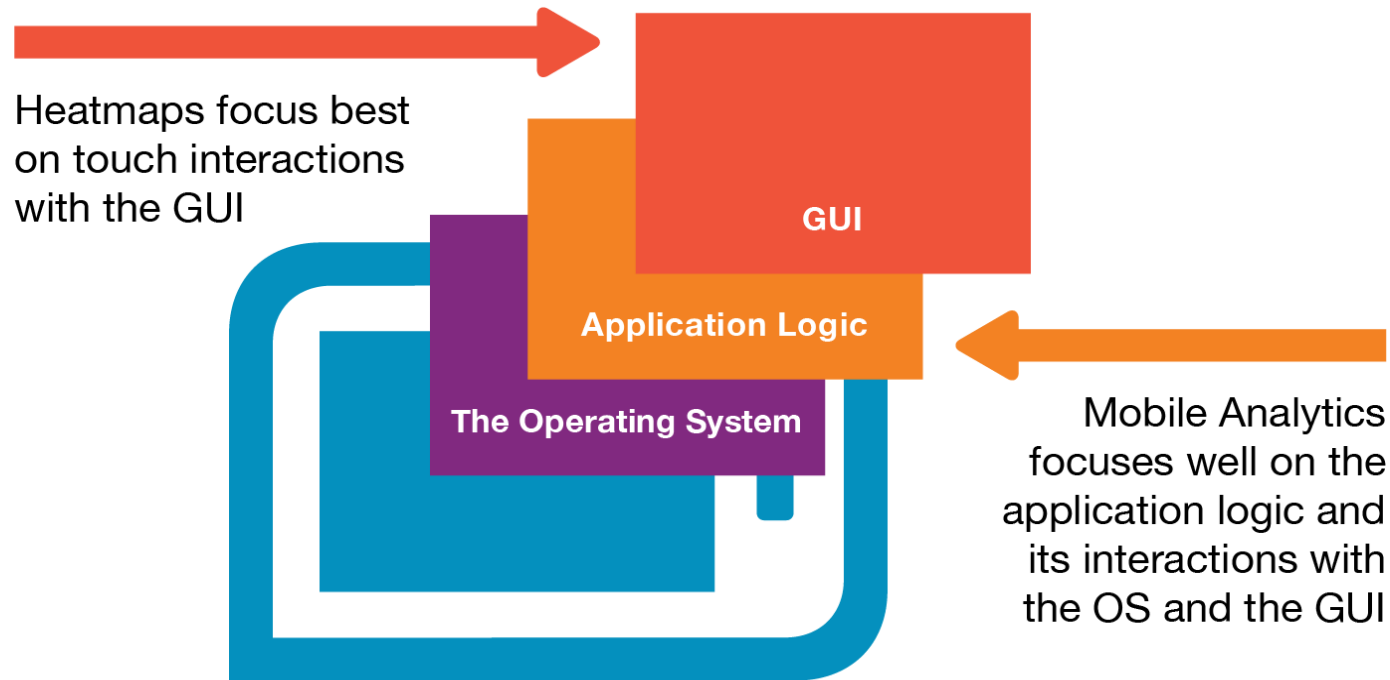
- No longer limited to what “we” think “they” need/do/etc.
Discover how the app behaves across virtually all the population
- Lower cost of operations
- Real usage can help drive our testing and analysis; brings realism to our testing



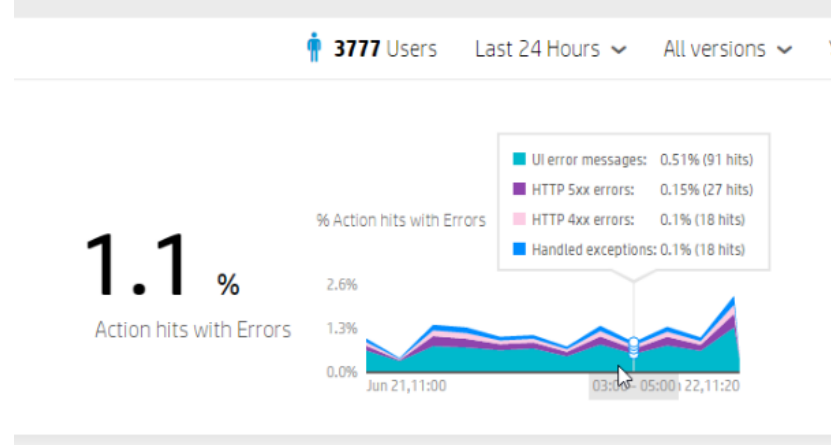
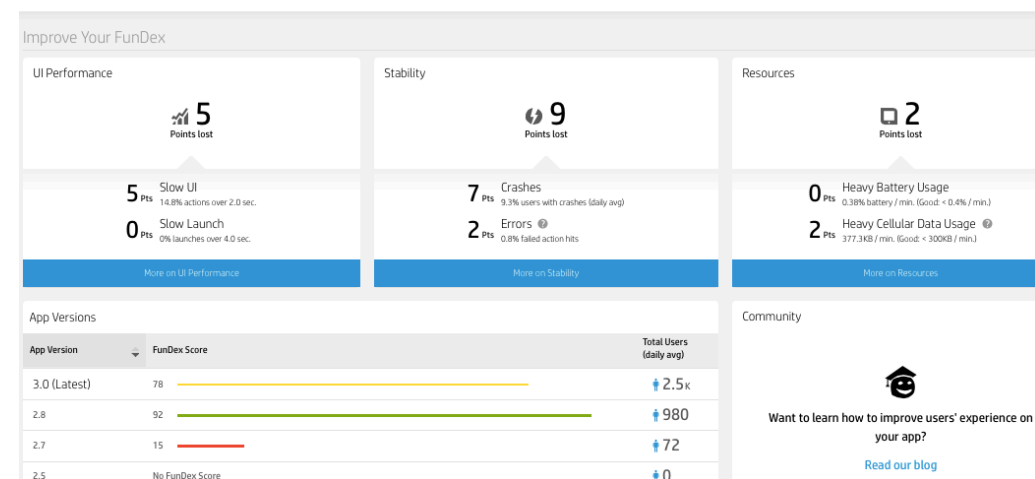
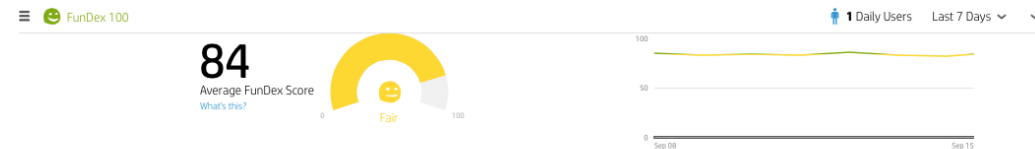
USE ANALYTICS & HEATMAPS

An overview

Layers of an App



Exploded view of the app running on the platform



User Actions

Top All Action

Most Used Actions

	Users (daily avg)	Hits (daily avg)	Screen	Action	Response Time (avg)	Users with crashes
	1	3	ContextThemeWrapper	Select item from drop down list	0.2s	0%
	1	1	ZimFileSelect	Tap the <u>Done</u> button	0.09s	0%
	1	1	Welcome to Kiwix!	Tap the <u>Ray-Charles-Demo.zim</u> item	0.7s	0%
	1	1	ZimFileSelect	Tap the <u>Rescan SD card</u> button	0.2s	0%
	1	1	KiwixSettings	Navigate back	0.0s	0%
★	1	1	KiwixMobile	Tap the <u>AppCompatEditText</u> button	0.1s	0%

Mobile Analytics

HPE AppPulse Mobile

Type

Crashes

ANRs

Show hidden

YES

NO

Last reported

Last 7 days

Android version

All versions







Application version

All versions

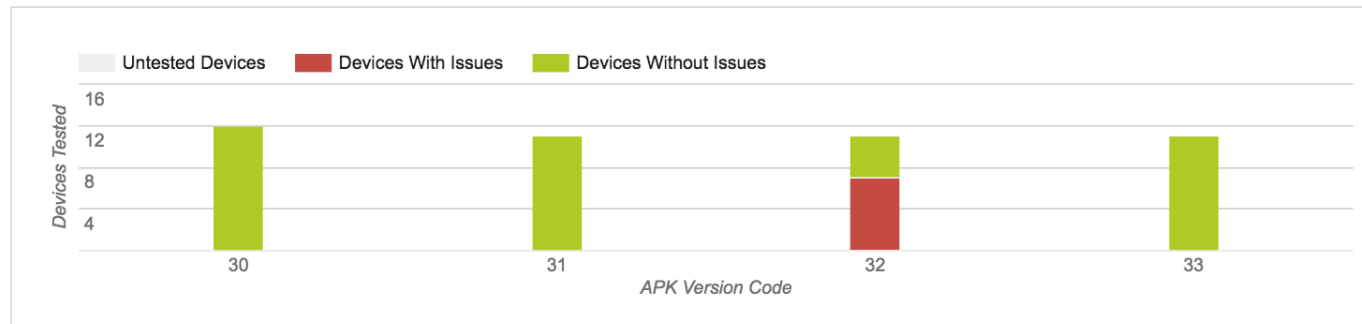
Device

Add filter

3 new crashes  | 5 total crashes

NAME	NEW 	REPORTS THIS WEEK	REPORTS TOTAL	LAST REPORTED
java.lang.NullPointerException in org.kiwix.kiwixmobile.ZimFileSelectFragment.deleteSpecificZi...	NEW		1	Oct 11, 1:08 AM
java.lang.ClassNotFoundException in dalvik.system.BaseDexClassLoader.findClass	NEW		1	Oct 9, 11:41 PM
Native crash at /system/lib64/libc.so in /system/lib64/libc.so (tgkill+8), /system/lib64/libc.so (pthread_...	NEW		1	Oct 9, 7:39 AM
java.lang.IndexOutOfBoundsException in java.util.ArrayList.throwIndexOutOfBoundsException			70	Oct 10, 8:41 AM
Native crash at /data/dalvik-cache/arm/data@app@org.kiwi... in /data/dalvik-cache/arm/data@app@org.kiwix.kiwixmobile-1 @...			2	Oct 9, 12:13 AM

Crash analytics



TEST RESULTS FOR APK VERSION 32

Devices With Issues 7	Devices Without Issues 4	Devices Tested 11
---------------------------------	------------------------------------	-----------------------------

DEVICES

All

Issues

	MODEL NAME	ANDROID VERSION	LOCALE	DESCRIPTION
❌	Moto G (1st Gen)	Android 4.4	Hindi	android.view.InflateException: Binary XML file line #60: Error inflating class Button
❌	LG G3	Android 4.4	English	android.view.InflateException: Binary XML file line #60: Error inflating class Button
❌	Nexus 5	Android 4.4	Arabic	-
❌	Galaxy Note3	Android 4.4	English	android.view.InflateException: Binary XML file line #60: Error inflating class Button
❌	HTC One (M8)	Android 4.4	English	-
❌	Moto G (2nd Gen)	Android 4.4	English	-
❌	Moto X (2nd Gen)	Android 4.4	English	-
✅	Nexus 7	Android 5.0	English	-
✅	Nexus 9	Android 5.0	English	-
✅	Nexus 5	Android 5.1	English	-
✅	Galaxy S6	Android 5.1	English	-

Pre-launch automated testing

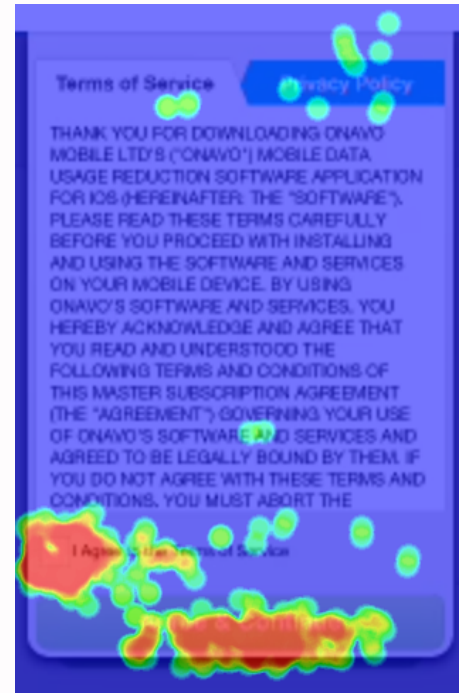
Heatmaps

“8 Heatmap Tests that reveal visitor behavior.”

1. [The Link Test](#) – Are visitors clicking on dead ends?
2. [The Distraction Test](#) – Are irrelevant elements distracting visitors?
3. [The Information Test](#) – Is there missing information from your page?
4. [The Device Test](#) – Does your page work on different screen sizes?
5. [The Depth Test](#) – Is all your content easily reachable?
6. [The Engagement Test](#) – What are your site visitors really looking for?
7. [The Fold Test](#) – Does your page have what it takes to keep your visitors?
8. [The Header Test](#) – Is your page header helping or hurting your site?



Problematic UI



Heatmap

Source: <https://www.hotjar.com/heatmaps>

26-28/10/2016

Images source: Appsee.com



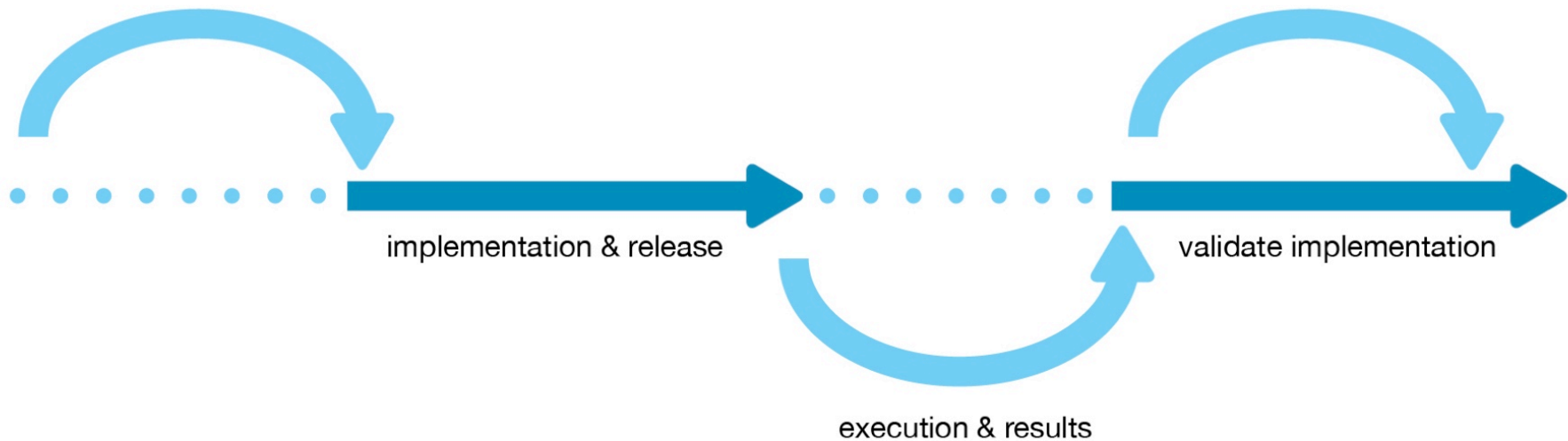
TESTING USING MOBILE ANALYTICS

Some examples

How did we do? & What next?

Design events to gather data
to validate ideas, assumptions
& verify quality-in-use

Review and assess the results of
our work. Also use the results to
design tests for the current and
future releases.












Feedback cycles between testing and mobile analytics for the app

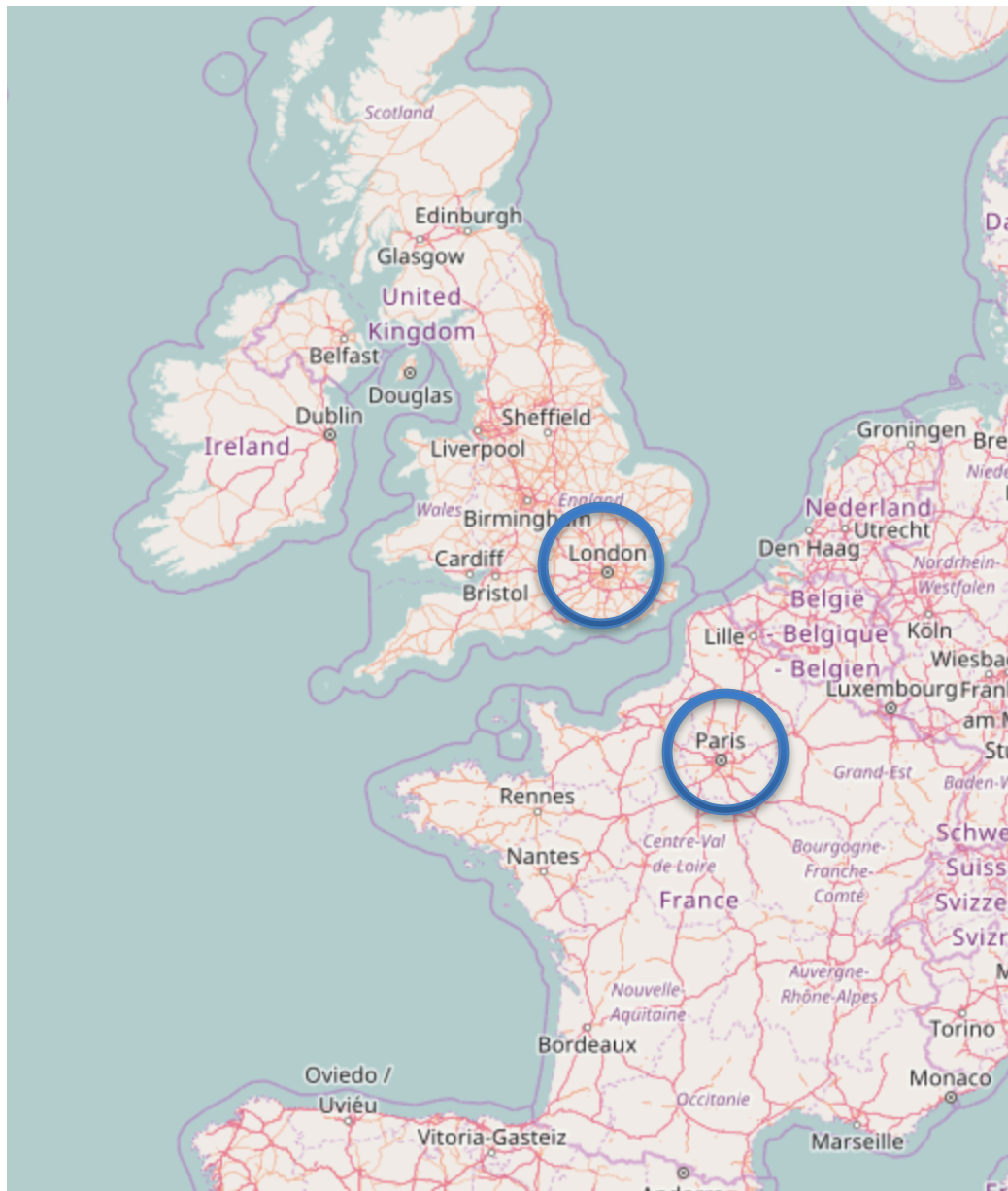
A basic example

Language	Sessions	% Sessions
1. en-us	19	55.88%
2. en-gb	6	17.65%
3. nl	6	17.65%
4. es	2	5.88%
5. tr	1	2.94%

City	Sessions	% Sessions
1. Dublin	9	26.47%
2. Bengaluru	3	8.82%
3. Boston	3	8.82%
4. Kingston	2	5.88%
5. Malaga	2	5.88%
6. Cambridge	2	5.88%
7. Utrecht	2	5.88%
8. Montreal	1	2.94%
9. Boulogne-Billancourt	1	2.94%
10. High Wycombe	1	2.94%

Country	Sessions	% Sessions
1.  Ireland	10	29.41%
2.  United States	6	17.65%
3.  United Kingdom	4	11.76%
4.  India	4	11.76%
5.  Canada	3	8.82%
6.  Netherlands	3	8.82%
7.  Spain	2	5.88%
8.  France	1	2.94%
9.  Turkey	1	2.94%

- Knowing the language and country of users can help us improve our testing
- Compare with the languages and locations we expected would use the app

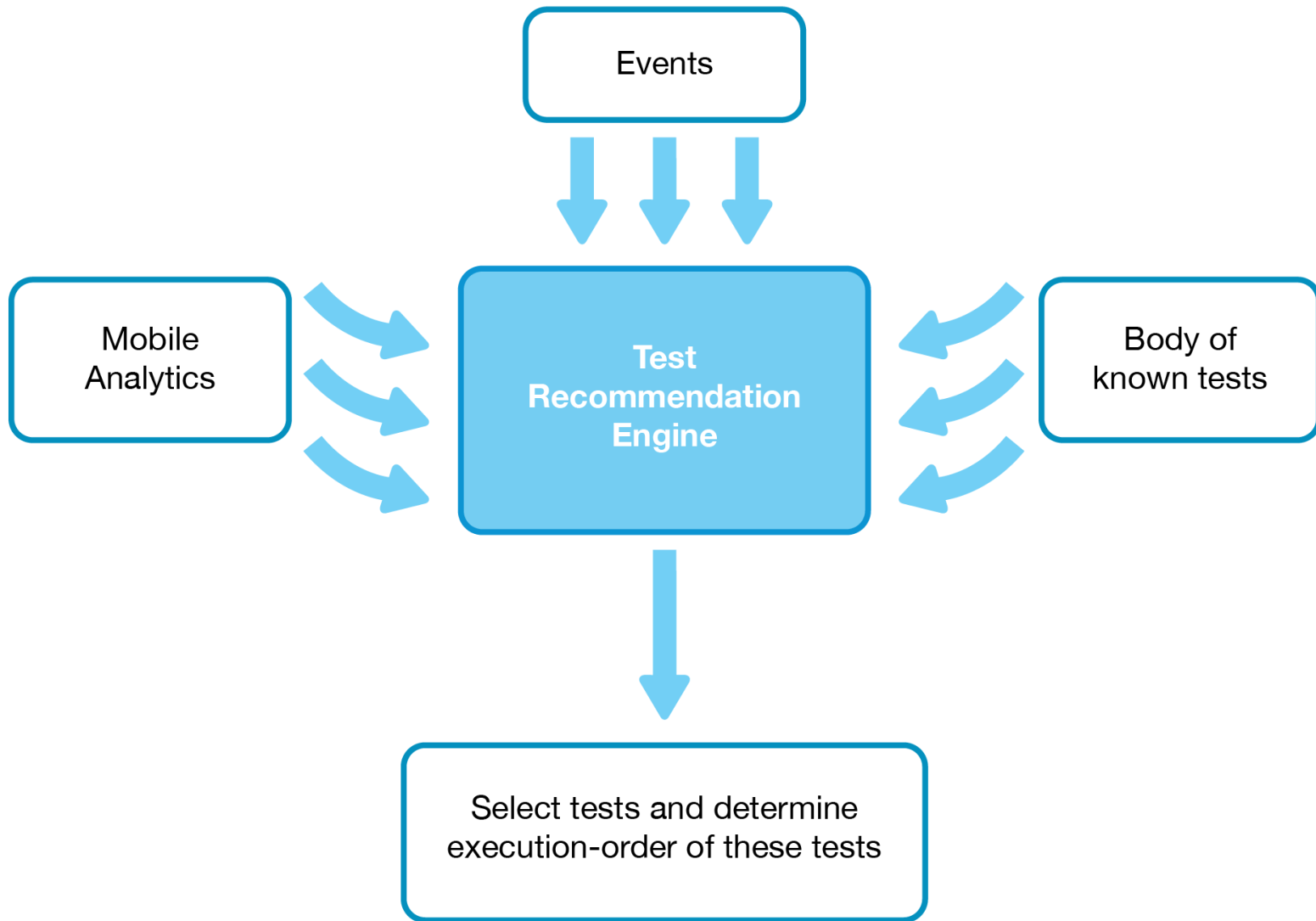


Where the testers were

Where the users were

Devise new tests

- Model tests on ways the app is being used in-the-field
 - Navigation journeys in the GUI
 - Searching
- We may need to extrapolate and provide extra parameters
- We may want to distort, twist, aggrandize & magnify to test beyond the current uses as an early-warning RADAR





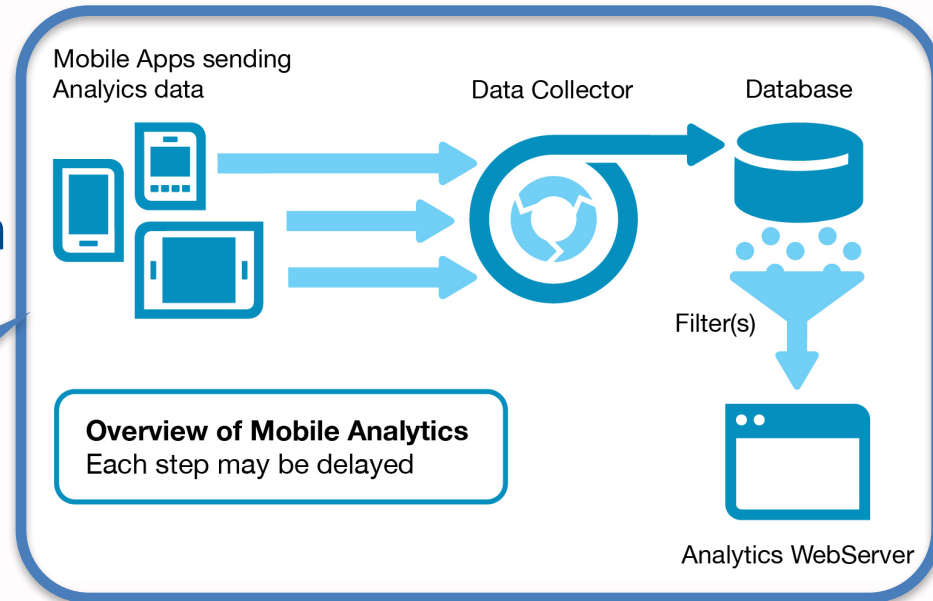
ESTABLISHING STRONG FOUNDATIONS

Things to do before launch

Test the mobile analytics

- Mobile analytics need to earn their trust
- We need to test the library, reports, and other aspects, in order to:
 - know how they behave &
 - how much we can trust them

Test the components
and the overall service





EXERCISE

Test ideas for testing mobile analytics

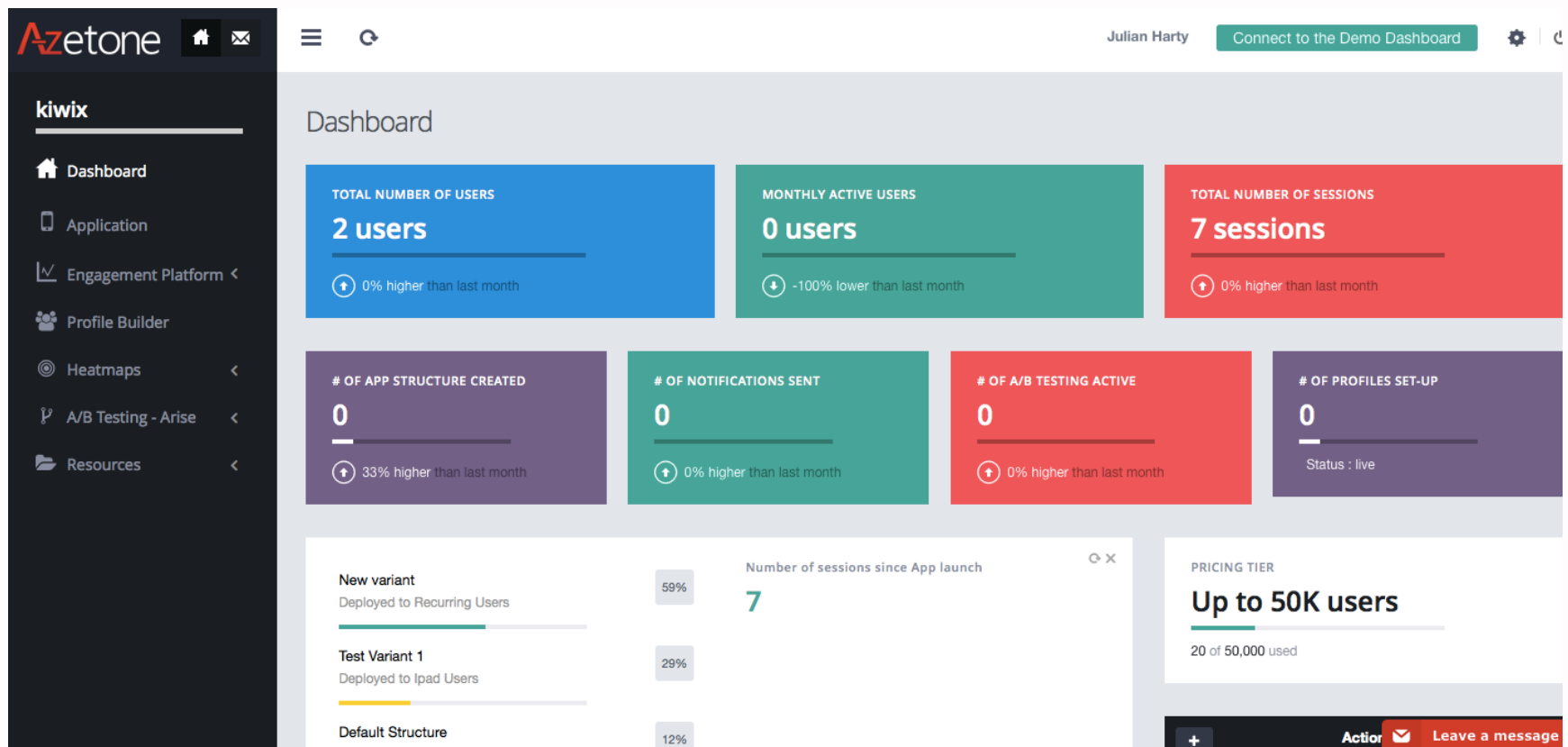
Some test ideas for mobile analytics

- Test the mechanics:
 - does the software *work*?
 - Can I trust it will *report correctly and completely*?
 - Even when there was no connectivity, across timezones & for all locales and languages
- Is it useful?
 - Does it allow you to easily report the information you need?
 - Standard & custom data
- Is it efficient? Trustworthy? Privacy preserving?

Divergent answers increase doubt

- * A tale of ~~two~~ three mobile analytics libraries
- * (and what happens when bonuses are on the line...)
- * Who is Responsible (part 1)?

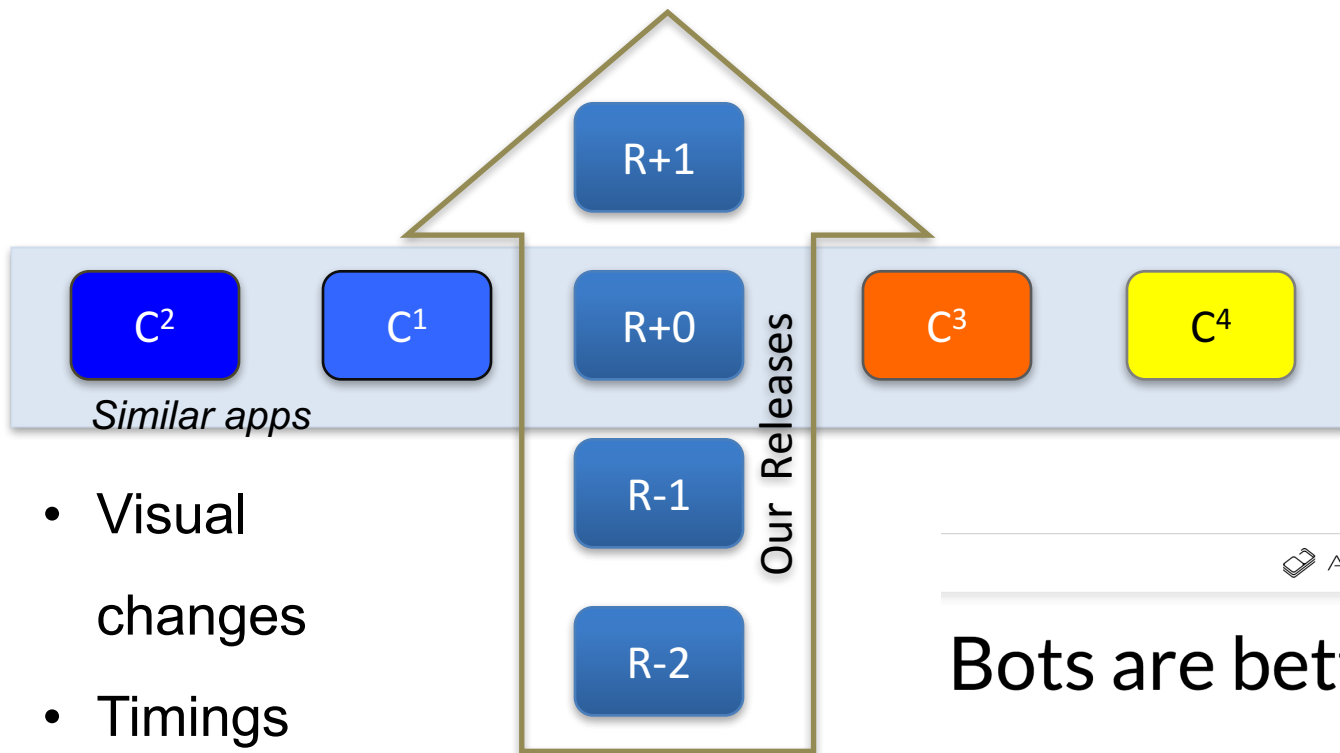
A system at rest?





COMPLEMENTARY APPROACHES

Can improve effectiveness
and cross correlation



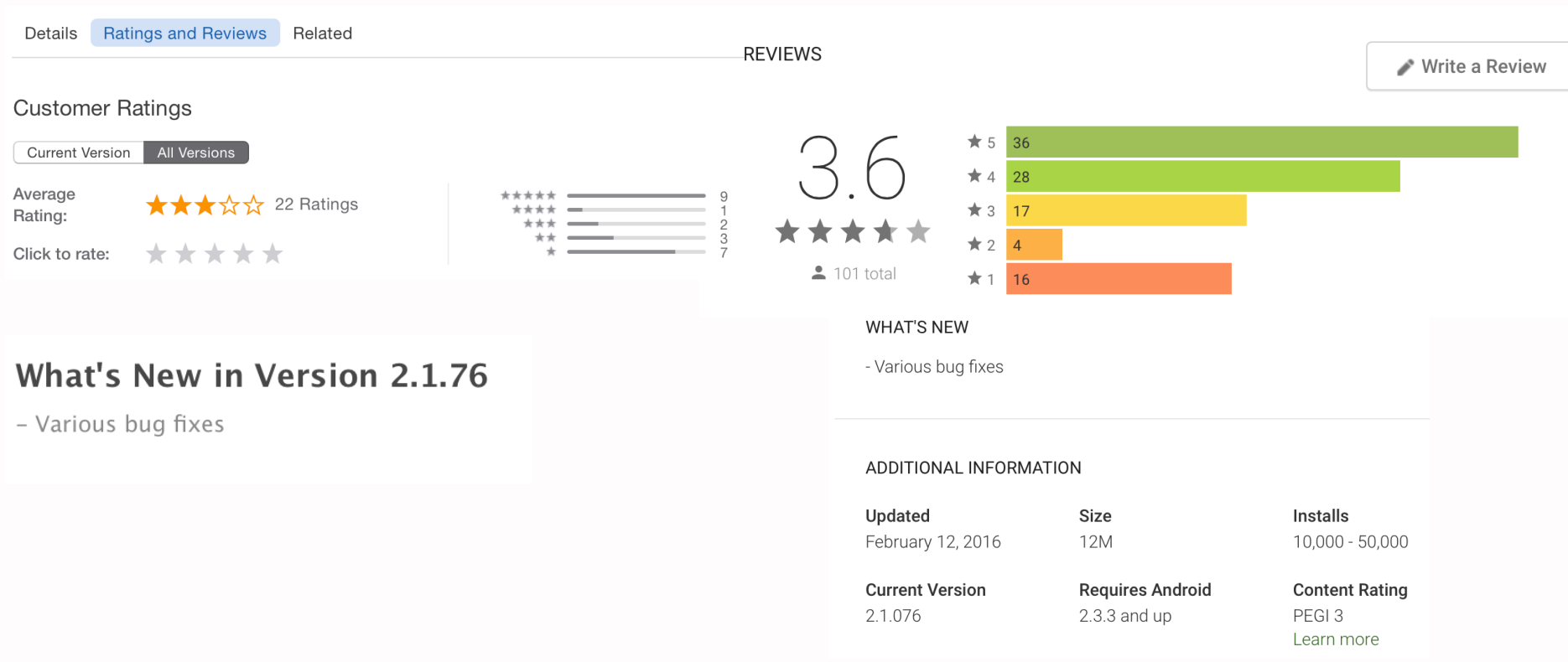
Bots are better

The smartest and simplest way to test. Intelligent bots tap, type, and swipe through your mobile app while measuring performance and tracking the user experience. No setup, no code, just results in minutes.

For example: <https://www.appdiff.com/>

Heuristic Test Oracles

An example of App Store Ratings



<https://itunes.apple.com/us/app/xpocast/id538003615?mt=8>

<https://play.google.com/store/apps/details?id=air.com.inxpo.xpocast&hl=en>

26-28/10/2016

**User Conference on
Advanced Automated Testing**

An example of App Store Reviews

Great conference platform with limitations ★★★★★
by mattfite – Jul 16, 2015

I use this application to attend online conferences. As other reviewers have noted, the application disrupts your session when the phone displays a notification and the application then requires you to sign in again. Other problematic "feature": viewing conference handouts, PDFs, etc., will also disrupt your session and require you to sign back in.

BusinessUser47 ★★★★★
by Mlotzof – Aug 2, 2012

Amazing what can be done on the iPad today. Using this tool I can sit at home, watch a presentation with video, slides and desk top sharing, while collaborating with the speaker via moderated chat and other viewers via group chat. Keep it coming.

Does not work? ★☆☆☆☆
by C-EFT – Nov 18, 2015

I am not sure I can fully agree with JPriestly and ElegantSD, but probably only because this app does not work for me at all on iOS 9.2. The version checker (what cumbersome and annoying a way to get into the app) complains that JavaScript is not enabled even though it is. The help link provided, leads to an article for OS X Safari, useless for iOS. Customer support, ... [more](#)

Was this review helpful? Yes | No | Report a Concern

Works but has issues. ★★★★★
by bgunther – Feb 4, 2015

Works great but when I get a popup on my phone for low battery or notification it kicks me out of the conference and I have to log back in through the website.

Was this review helpful? Yes | No | Report a Concern

Meh ★★★★★
by Il Liberatore – Oct 21, 2015

The app delivers low resolution video while hiding the clock. If you switch to another app then come back it requests that you return to your browser to click on the meeting link again which is really hokey. This is all based on an interaction with the 2015 Tabelau conference.

<https://itunes.apple.com/us/app/xpocast/id538003615?mt=8>

<https://play.google.com/store/apps/details?id=air.com.inxpo.xpocast&hl=en>



Antonín Faltýnek August 16, 2015
★★★★★

Missing audio-only mode, no background playback, no offline mode. At least it can resume playback from last position.



Kevin Micke January 29, 2015
★★★★★

Allow background audio When attending a webinar that doesn't have necessary video content, it's very frustrating that I can't turn the screen off and listen to the audio only. The most significant problem it is lag in the audio if I'm on a slow network because it has to download all the video, and it also wastes battery life. Also, any time you switch to another program the feed dies, and you have to go back to the browser to launch it again - it should reconnect on its own.



Ryan Ingram November 25, 2014
★★★★★

Works well Used it to view a web cast worked well even while traveling. Could do with recovering from total loss of signal though.



QD World November 26, 2014
★★★★★

How? Does this work the first page itself is asking for some Web? ?? Be more specific



Jenn W
★★★★★

Xpocast sucks Was recommended to use this for webcasts for my job, but can never get logged in from the email sent to me. Doesn't work on galaxy s4.



Worth knowing about reviews

Influence

Jumping from...	To...	Is Expected to Increase App Store Conversion by...
★	★★	30%
★	★★★	340%
★	★★★★	730%
★	★★★★★	770%
★★	★★★	280%
★★	★★★★	540%
★★	★★★★★	570%
★★★	★★★★	89%
★★★	★★★★★	97%
★★★★	★★★★★	4%

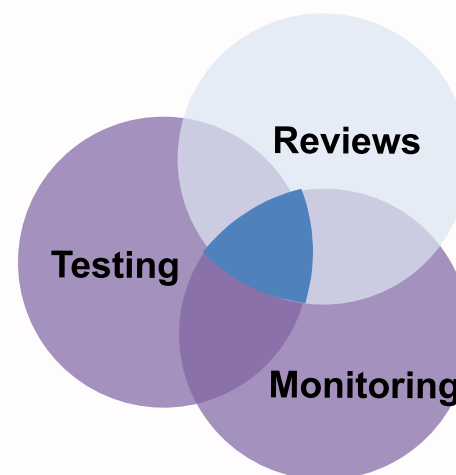
Source: Apptentive 2015 Consumer Survey
The Mobile Marketer's Guide to Ratings & Reviews



Measure and Engage



Improve



Reviews affect the app ranking and the app store conversion. They are also critical for Search Engine Optimization.

Reviews have multiple dimensions which can be used to help measure the user experience.

Turn users' input into innovation

Know your users



Custom drink feature removed^[1]
=> **1 star feedback** ratings



Parallel Kingdom^[2]

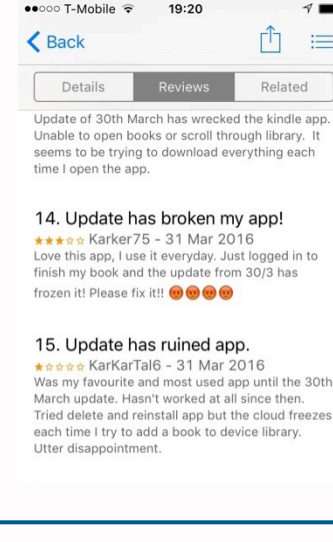
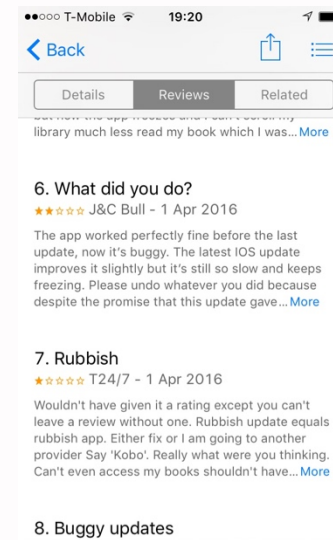
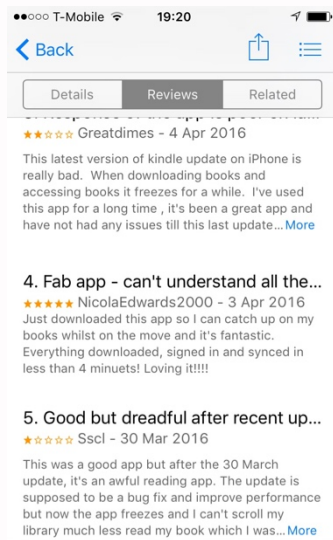
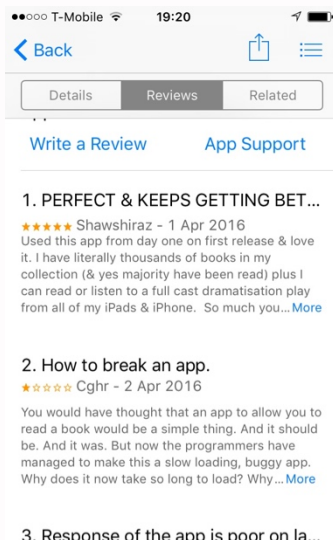
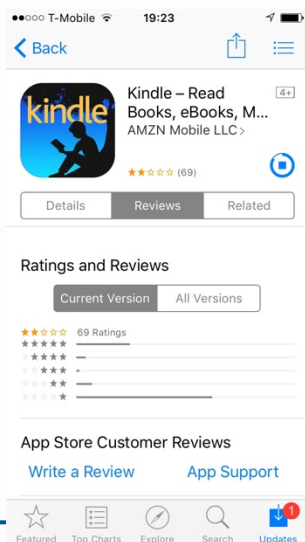
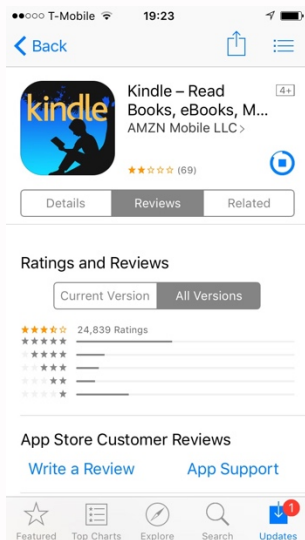
Regular users generate **2.5x daily**
revenues

Logos © respective owners

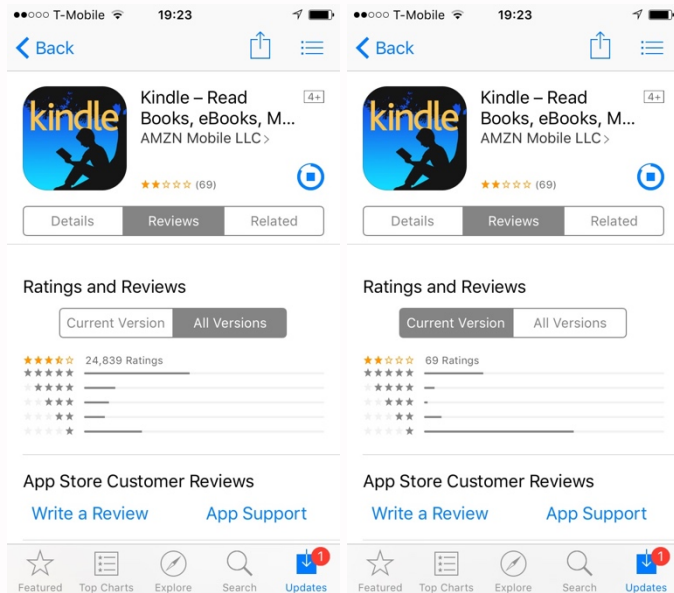
[1] example from App Quality book

[2] example from Tale of Two Apps

Kindle App for iOS



Kindle App for iOS



Customer Ratings

Current Version:

★★★ 22 Ratings

All Versions:

★★★★ 222887 Ratings

06 Apr 2016

Customer Ratings

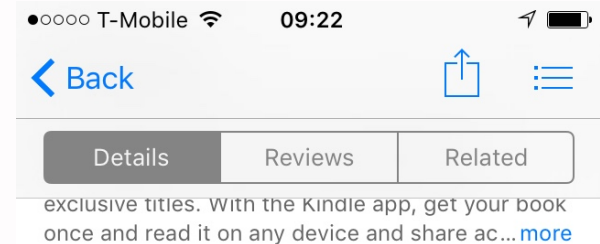
Current Version:

★★★★★ 565 Ratings

All Versions:

★★★★ 25393 Ratings

03 May 2016



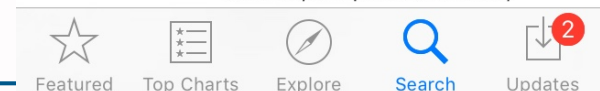
What's New

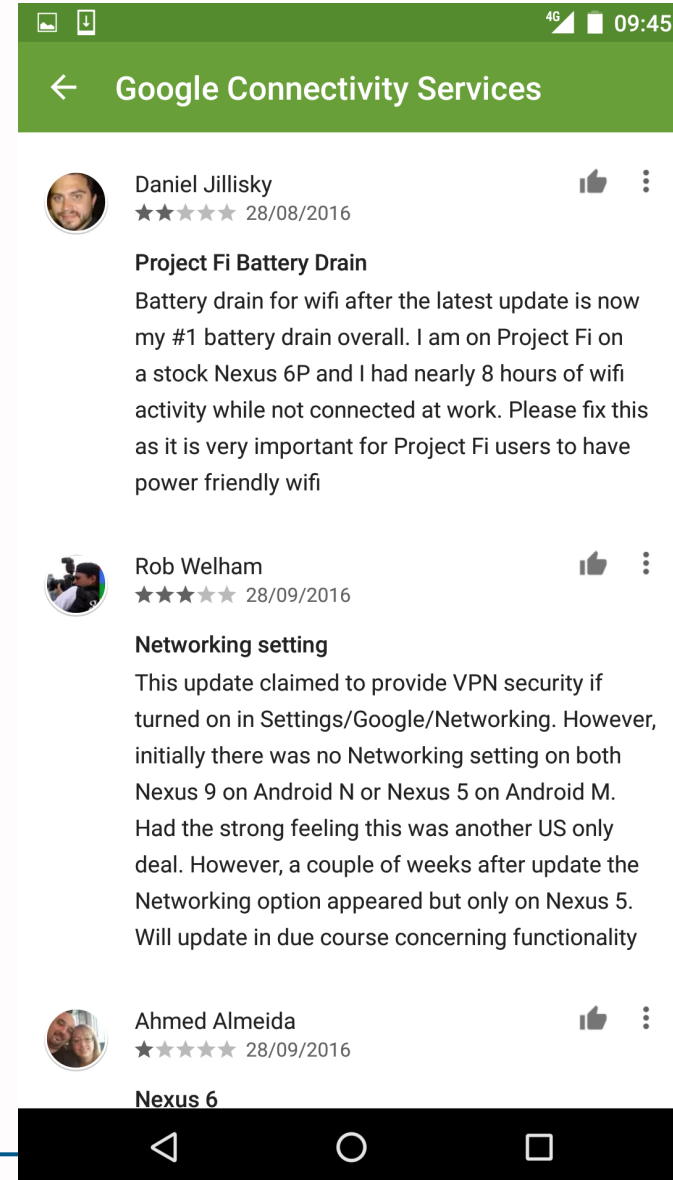
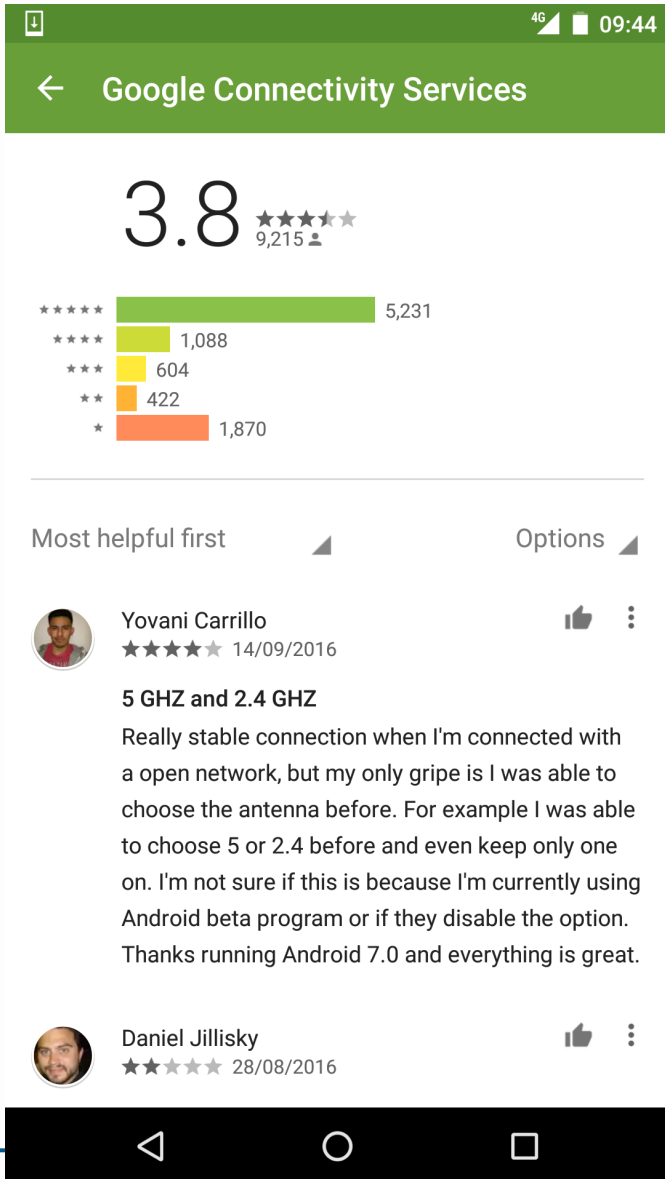
5 Apr 2016

Performance and stability improvements

Information

Developer	AMZN Mobile LLC
Category	Books
Updated	4 Apr 2016
Version	4.19.1
Size	86.9 MB
Rating	Rated 4+
Family Sharing	Yes
Compatibility	Requires iOS 8.0 or later. Compatible with iPhone, iPad, and iPod touch.
Languages	English, Dutch, French, German, Italian, Japanese, Portuguese, Russian, Simplified Chinese,





Google Play Developer Console



Kiwix, Wikipedia offline

org.kiwix.kiwixmobile [View in Play store](#)

PUBLISHED September 4, 2016

Standard publishing ▼

Statistics

User Acquisition

Ratings & Reviews

Ratings

Reviews Analysis

Reviews

Beta Feedback

Crashes & ANRs

Optimization Tips

Pre-Launch Report

Promotions

APK

Store Listing

Content Rating

REVIEWS ANALYSIS

BENCHMARKS & TOPICS

All APK versions ▾ 1 year ▼

Identify and understand trends in your app's reviews. Review analysis features use ratings from reviews written in English and aren't shown to users. [Learn more](#)

BENCHMARKS

Benchmarks show your app's ratings for a fixed set of topics and compare these ratings with similar apps in the **Books & Reference** category.

COMMON TOPIC ▲ ?	AVERAGE RATING	RATING VERSUS PEERS	NUMBER OF REVIEWS	NUMBER VERSUS PEERS	EFFECT ON RATING ?
Resource usage ?	3.500 ★	+0.083 ★	4	5.78 x	
Speed ?	4.364 ★	+0.364 ★	11	2.84 x	
Stability ?	2.923 ★	+0.243 ★	26	3.09 x	
Uninstalls ?	2.000 ★	+0.159 ★	4	4.68 x	
Update ?	4.727 ★	+1.248 ★	22	5.58 x	
Usability ?	4.200 ★	-0.467 ★	10	0.58 x	



EXERCISE

Devising test ideas from reviews in the app store



MACRO PERSPECTIVE

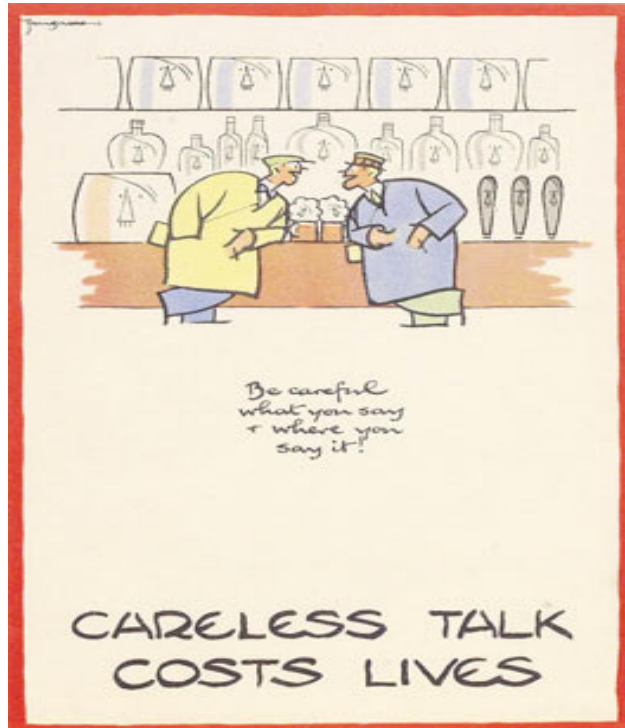
Opening up the subject for possible future works



THE DARK SIDE

Of using Mobile Analytics

Do no harm



THIS POPULAR FLASHLIGHT APP HAS BEEN SECRETLY SHARING YOUR LOCATION AND DEVICE ID

MORE THAN 50 MILLION USERS WERE LEFT IN THE DARK ABOUT HOW BRIGHTEST FLASHLIGHT SHARED THEIR LOCATION AND DEVICE INFORMATION WITH THIRD PARTIES.



Blog

iOS Apps Caught Using Private APIs 

October 18, 2015

CHINESE TAOMIKE MONETIZATION LIBRARY STEALS SMS MESSAGES

Palo Alto Networks WildFire has captured over 18,000 Android apps that contain this library.
(October 21, 2015)



Who is Responsible (Part 2)?

<http://www.vam.ac.uk/users/node/1777>

A Study of Third-Party Tracking by Mobile Apps in the Wild
<ftp://ftp.cs.washington.edu/tr/2012/03/UW-CSE-12-03-01.PDF>

<https://sourcedna.com/blog/20151018/ios-apps-using-private-apis.html>

<http://researchcenter.paloaltonetworks.com/2015/10/chinese-taomike-monetization-library-steals-sms-messages/>

Beware the automation bias

“When presented with an automated solution 40% of pilots reasoned less or none at all”

Automation Bias in Intelligent Time Critical Decision Support Systems

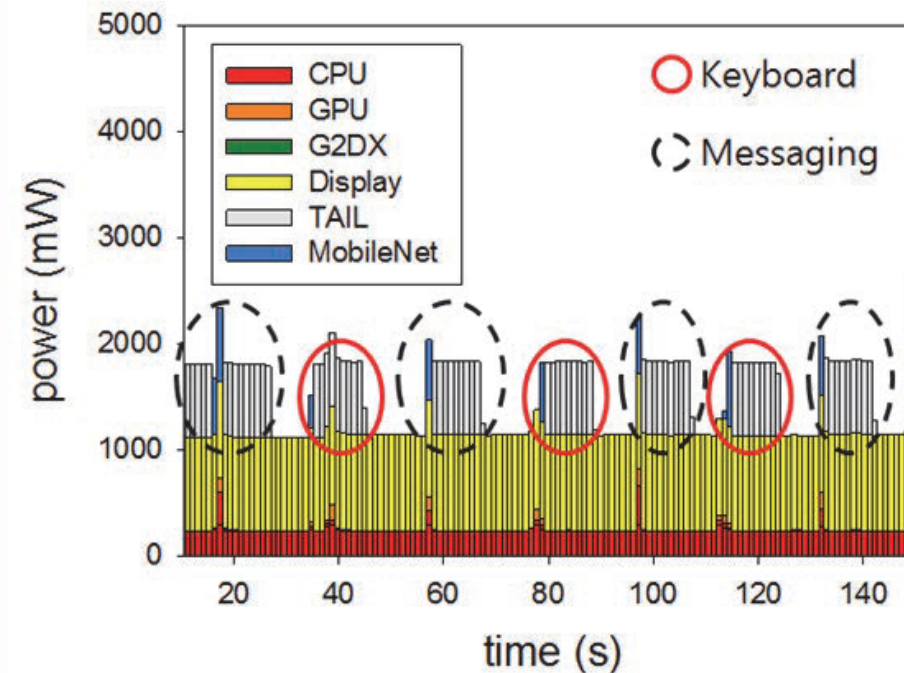
<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.91.2634&rep=rep1&type=pdf>



NECESSARY BUT NOT SUFFICIENT

Listening is a means to an end

Correlation? Causation? Appropriate?



From: User Interaction-based Profiling System for Android Application Tuning
Figure © ACM



GAPS IN PUBLISHED WORKS

Where can you help?

Possible gaps in known research

- Mapping + Matching data to tests
- Sweet-spot for data collection
- Granularity, fidelity, accuracy





Mapping & Matching

What are the relationships between analytics data & the tests?

Considerations:

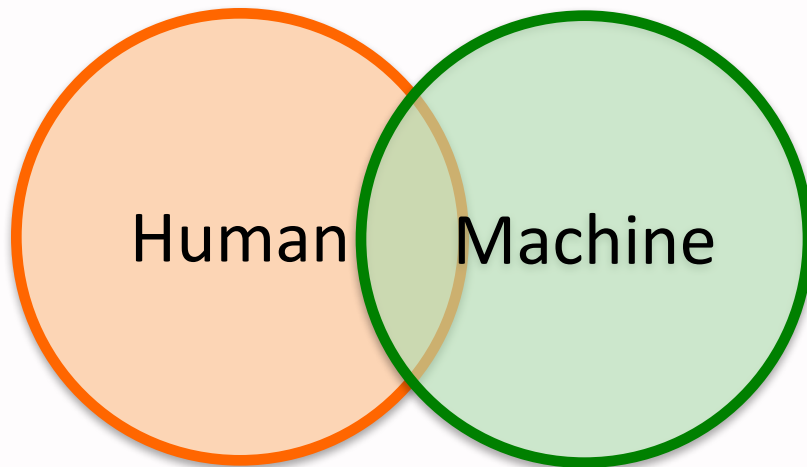
- Semantics of data available to test inputs
- Known fields: known to the programmers e.g. from API docs
- Defined fields: created and identified by the programmers

How can external data be mapped & matched to current tests?

Screen Resolution	Sessions	% Sessions
1. 360x640	3	 37.50%
2. 600x1024	3	 37.50%
3. 320x534	1	 12.50%
4. 375x667	1	 12.50%

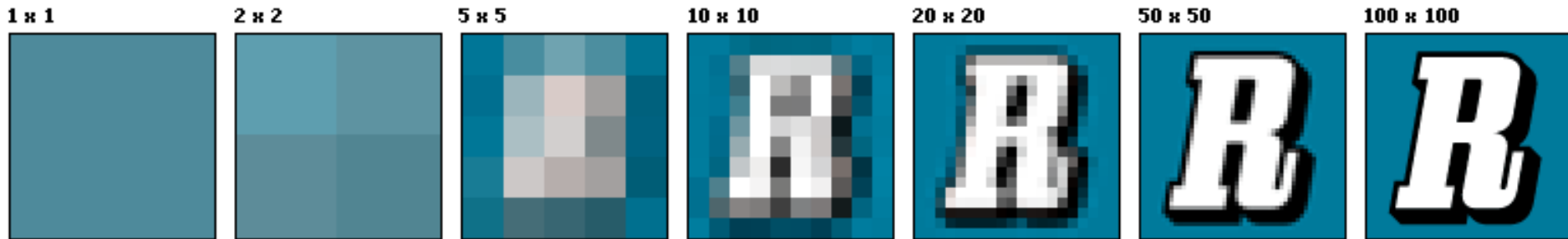
Sweet spot for data collection & retention

- Too little ain't enough
- Too much is excessive and problematic
- Tradeoffs for amounts between these limits



Aspect	Human	Machine
PII, Trust, Safety	Y	
Transmission costs	Y	
Client-side performance	Y	Y
Server-side performance		Y

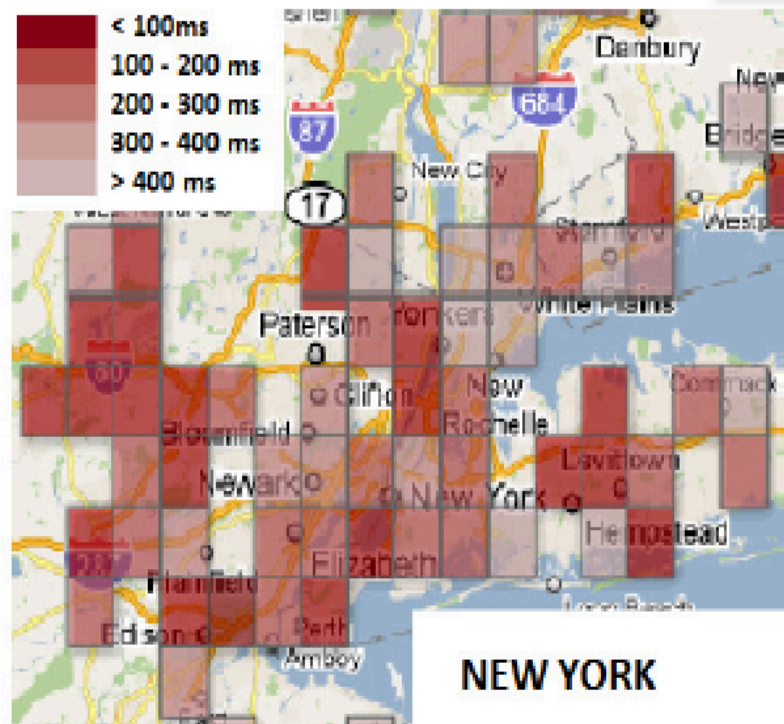
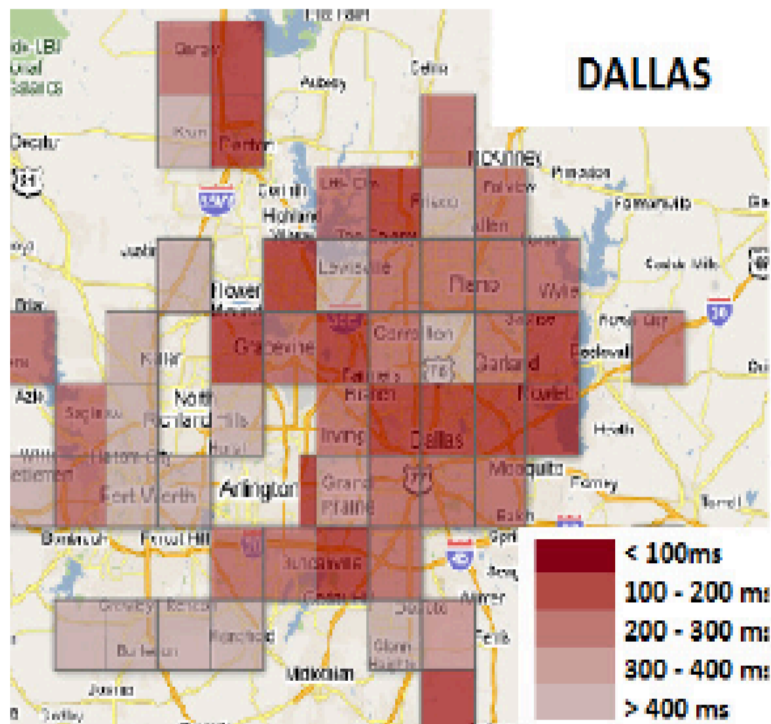
Granularity, Fidelity, Accuracy



https://commons.wikimedia.org/wiki/File:Resolution_illustration.png

- How much detail do we need to find value in the data?
- How closely do we need to match the source data

Reducing precision to protect privacy



10km x 10km squares

From: Capturing Mobile Experience in the Wild: A Tale of Two Apps

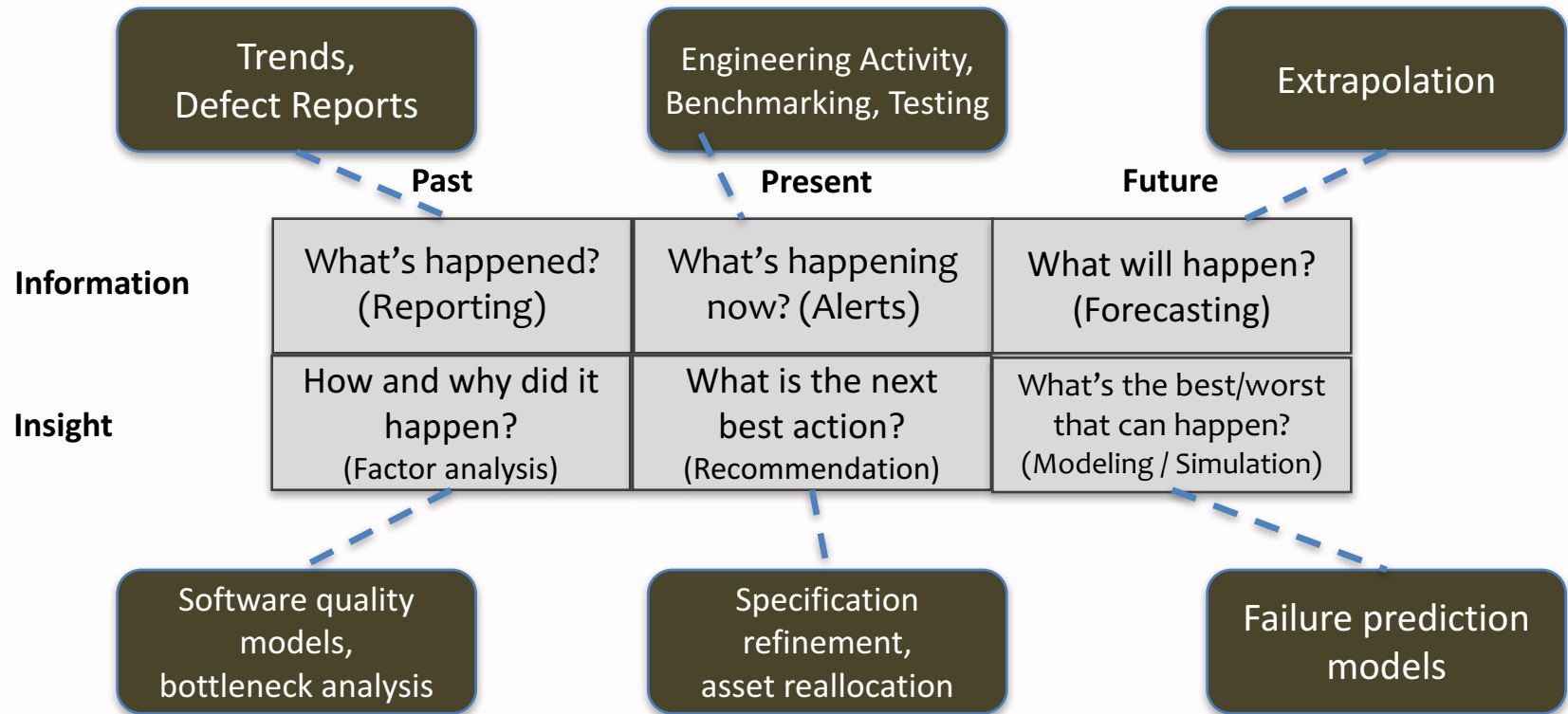
Figure © ACM



FOREIGN FIELDS

What might we learn from
beyond our microcosm?

Analytics for Software Development



<http://research.microsoft.com/pubs/136974/foser-2010-buse.pdf>

Quotes from medical articles

Possible applications to testing software

“High Value Care improves health, avoids harms, and eliminates wasteful practices.”

Better testing improves the health of the software and the team, avoids harm and eliminates wasteful practices.

<https://www.acponline.org/clinical-information/high-value-care>

[1] Perhaps can we learn from medicine?

Quotes from medical articles Possible applications to testing software

“1-Minute Consults, called Smart Testing”

Lightweight, fast assessments can help improve our practices.

[http://www.ccjm.org/?id=105745&tx_ttnews\[tt_news\]=369817&cHash=25e67e4e823dd22a9e41a94a7cd30202](http://www.ccjm.org/?id=105745&tx_ttnews[tt_news]=369817&cHash=25e67e4e823dd22a9e41a94a7cd30202)

[2] Perhaps can we learn from medicine.

Quotes from medical articles	Possible application to testing software
<p>“The Smart Testing series examines scenarios in which diagnostic tests are commonly ordered in the absence of supporting data.</p> <p>The articles use evidence-based recommendations to clarify when testing is appropriate.</p> <p>Authors are encouraged to include specific examples of testing that may be excessive or harmful.”</p> <p>http://www.ccjm.org/corporate-links/journal-info/instructions/smart-testing-instructions.html</p>	<p>Evidence of the results of our testing, including assessments and retrospectives can help improve our testing.</p> <p>Focus, also, on discouraging testing that may be excessive or harmful.</p>

Quotes from medical articles

“ACP defines High Value Care as the delivery of services providing benefits that make their harms and costs worthwhile.

Value is not merely cost.”

"The Institute of Medicine has estimated that \$765 billion is wasted annually in the United States on care that provides no value to patients,"

<https://www.acponline.org/acp-newsroom/smart-testing-tackles-chief-culprits-of-wasted-care-unnecessary-imaging-procedures-and-diagnostic>

Possible applications to testing software

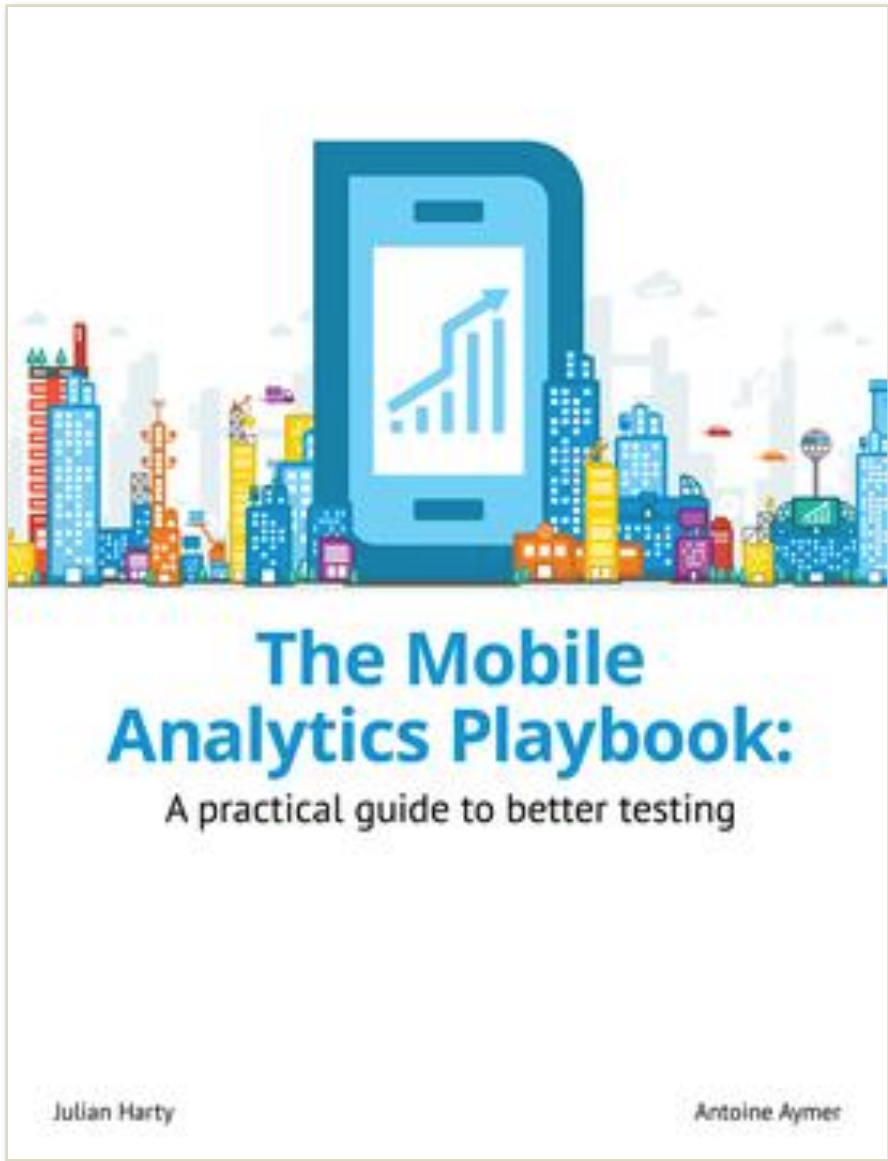
Only embark on implementing and using stuff where the benefits far outweigh the potential harms and costs.



WHAT NEXT?

Helping you to get started...

READ THIS BOOK 😊



Questions now?

Questions later...
julianharty@gmail.com

<http://themobileanalyticsplaybook.com/>

Further reading and research

Novel Applications of Machine Learning in Software Testing

<http://dx.doi.org/10.1109/QSIC.2008.29>

Automatic and Scalable Fault Detection for Mobile Applications

<http://dx.doi.org/10.1145/2594368.2594377>

Automation Bias in Intelligent Time Critical Decision Support Systems by M.L. Cummings

<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.91.2634&rep=rep1&type=pdf>

Designing and Engineering Time by Steven Stow

ISBN 978-0-321-50918-5

Google Analytics for Android <https://classroom.udacity.com/courses/ud876-2/>

https://github.com/udacity/Analytics_and_Tag_Manager