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

- Test Results
- In App Analytics
- In AppStore feedback
- Social Media feedback
Overview of Mobile Analytics
Each step may be delayed
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
Feedback

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

Heatmaps focus best on touch interactions with the GUI

Mobile Analytics focuses well on the application logic and its interactions with the OS and the GUI

Exploded view of the app running on the platform
### Crash analytics

<table>
<thead>
<tr>
<th>NAME</th>
<th>REPORTS THIS WEEK</th>
<th>REPORTS TOTAL</th>
<th>LAST REPORTED</th>
</tr>
</thead>
<tbody>
<tr>
<td>java.lang.NullPointerException</td>
<td></td>
<td></td>
<td>Oct 11, 1:08 AM</td>
</tr>
<tr>
<td>in org.kiwi.kiwxmobile.ZimFileSelectFragment.deleteSpecificZi…</td>
<td>NEW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>java.lang.ClassNotFoundException</td>
<td></td>
<td></td>
<td>Oct 9, 11:41 PM</td>
</tr>
<tr>
<td>in dalvik.system.BaseDexClassLoader.findClass</td>
<td>NEW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native crash at /system/lib64/libc.so</td>
<td></td>
<td></td>
<td>Oct 9, 7:39 AM</td>
</tr>
<tr>
<td>in /system/lib64/libc.so (tgkill+8), /system/lib64/libc.so (pthread__…</td>
<td>NEW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>java.lang.IndexOutOfBoundsException</td>
<td></td>
<td>70</td>
<td>Oct 10, 8:41 AM</td>
</tr>
<tr>
<td>in java.util.ArrayList.throwIndexOutOfBoundsException</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native crash at /data/dalvik-cache/arm/data@<a href="mailto:app@org.kiwi">app@org.kiwi</a>…</td>
<td></td>
<td>2</td>
<td>Oct 9, 12:13 AM</td>
</tr>
<tr>
<td>in /data/dalvik-cache/arm/data@app@org.kiwi.kiwxmobile-1@…</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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?

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

Implementation & release

Execution & results

Validate implementation

Feedback cycles between testing and mobile analytics for the app
A basic example

- 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

http://www.openstreetmap.org/#map=5/50.261/0.483
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
Test Recommendation Engine

Events

Mobile Analytics

Test Recommendation Engine

Body of known tests

Select tests and determine execution-order of these tests
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.
Heuristic Test Oracles

- Visual changes
- Timings
- Comparisons

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/
An example of App Store Ratings

Customer Ratings
- Average Rating: ★★★☆☆ 22 Ratings
- Click to rate: ★★★★★

What's New in Version 2.1.76
- Various bug fixes

Additional Information
- Updated: February 12, 2016
- Size: 12M
- Installs: 10,000 - 50,000
- Current Version: 2.1.076
- Requires Android: 2.3.3 and up
- Content Rating: PEGI 3

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 goanther – 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.

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
Tableau conference.

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

Antonin Faltynek 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

<table>
<thead>
<tr>
<th>Rating</th>
<th>Increase in App Store Conversion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>★</td>
<td>2%</td>
</tr>
<tr>
<td>★★</td>
<td>5%</td>
</tr>
<tr>
<td>★★★</td>
<td>7%</td>
</tr>
<tr>
<td>★★★★</td>
<td>10%</td>
</tr>
<tr>
<td>★★★★★</td>
<td>15%</td>
</tr>
<tr>
<td>★★★★★★</td>
<td>20%</td>
</tr>
<tr>
<td>★★★★★★</td>
<td>25%</td>
</tr>
<tr>
<td>★★★★★★</td>
<td>30%</td>
</tr>
</tbody>
</table>

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

Measure and Engage

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

Improve

Reviews

Testing

Monitoring

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

1. PERFECT & KEEPS GETTING BETTER
   Shaahvhirz - 1 Apr 2016
   Used this app from day one on first release & love it. I have literally thousands of books in my collection (80% majority have been read) plus I can read or listen to a full cast dramatisation play from all of my iPads & iPhone. So much you... More

2. How to break an app.
   Cgyr - 2 Apr 2016
   You would have thought that an app to allow you to read a book would be a simple thing. And it should be. And it was. But now the programmers have managed to make this a slow loading, buggy app. Why does it now take so long to load? Why... More

3. Response of the app is poor on iu...

4. Fab app - can't understand all the...
   NicolaEdwards2000 - 3 Apr 2016
   Just downloaded this app so I can catch up on my books whilst on the move and it's fantastic. Everything downloaded, signed in and synced in less than 4 minutes! Loving it!!!

5. Good but dreadful after recent up...
   '50 C - 30 Mar 2016
   This was a good app but after the 30 March update, it's an awful reading app. The update is supposed to be a bug fix and improve performance but now the app freezes and I can't scroll my library much less read my book which i was... More

6. What did you do?
   J&C Bull - 1 Apr 2016
   The app worked perfectly fine before the last update, now it's buggy. The latest iOS update improves it slightly but it's still so slow and keeps freezing. Please undo whatever you did because despite the promise that this update gave... More

7. Rubbish
   T247 - 1 Apr 2016
   Wouldn't have given it a rating except you can't leave a review without one. Rubbish update equals rubbish app. Either fix it or I am going to another provider Say 'Kobo'. Really what you were thinking. Can't even access my books shouldn't have... More

8. Buggy updates

9. Awful
   TeamEdward100 - 3 Apr 2016
   Not a bad app but the last couple of updates seem to have screwed up syncing of the current page. Opening the app now results in a random page being opened instead of the last page I was on.

10. App update ruined my kindle on...
    Miiki - 30 - 31 Mar 2016
    What on earth have you done?!??! I was happily reading and then the app updated and I haven't been able to carry on reading! The book is stuck on the same page, then when it in freezes the app closes and it's back on the page you started... More

11. Oh No...awful after update
    Lwol - 3 Apr 2016
    What on earth have they done to this app...it was just fine before the latest update. But now, it freezes, goes so slow to download books, text is wonky and page turn sometimes doesn't register. What a shame, not sure what happened... More

12. Latest update
    e0p0e - 31 Mar 2016
    The latest update has messed up my kindle app. I've never had issues before until this update. I don't want to uninstall and then install again. I have so many books and collections and I don't want to start all over again!

13. Not working since today's update
    Rynnath - 31 Mar 2016
    Update of 30th March has wrecked the kindle app. Unable to open books or scroll through library. It seems to be trying to download everything each time I open the app.

14. Update has broken my app!
    KarKarTafe - 31 Mar 2016
    Love this app, I use it everyday. Just logged in to finish my book and the update from 30/3 has frozen it! Please fix it... More

15. Update has ruined app.
    KarKarTafe - 31 Mar 2016
    Was my favourite and most used app until the 30th March update. Haven't worked at all since then. Tried delete and re-install but the cloud freezes each time I try to add a book to device library. Utter disappointment.
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

User Conference on Advanced Automated Testing

26-28/10/2016
Reviews for Google Connectivity Services

3.8 ★★★★★ 9,215

★★★★★ 5,231
★★★★ 1,088
★★★ 604
★★ 422
★ 1,870

Most helpful first

Yovani Carrillo ★★★★★ 14/09/2016

5 GHZ and 2.4 GHZ
Really stable connection when I’m connected with a open network, but my only gripe is I was able to choose the antenna before. For example I was able to choose 5 or 2.4 before and even keep only one on. I’m not sure if this is because I’m currently using Android beta program or if they disable the option. Thanks running Android 7.0 and everything is great.

Daniel Jillisky ★★★★★ 28/08/2016

Project Fi Battery Drain
Battery drain for wifi after the latest update is now my #1 battery drain overall. I am on Project Fi on a stock Nexus 6P and I had nearly 8 hours of wifi activity while not connected at work. Please fix this as it is very important for Project Fi users to have power friendly wifi

Rob Welham ★★★★★ 28/09/2016

Networking setting
This update claimed to provide VPN security if turned on in Settings/Google/Networking. However, initially there was no Networking setting on both Nexus 9 on Android N or Nexus 5 on Android M. Had the strong feeling this was another US only deal. However, a couple of weeks after update the Networking option appeared but only on Nexus 5. Will update in due course concerning functionality

Ahmed Almeida ★★★★★ 28/09/2016

Nexus 6
## Reviews Analysis

### Benchmarks & Topics

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.

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

Careless talk costs lives

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

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?

<table>
<thead>
<tr>
<th>Screen Resolution</th>
<th>Sessions</th>
<th>% Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 360x640</td>
<td>3</td>
<td>37.50%</td>
</tr>
<tr>
<td>2. 600x1024</td>
<td>3</td>
<td>37.50%</td>
</tr>
<tr>
<td>3. 320x534</td>
<td>1</td>
<td>12.50%</td>
</tr>
<tr>
<td>4. 375x667</td>
<td>1</td>
<td>12.50%</td>
</tr>
</tbody>
</table>
Sweet spot for data collection & retention

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

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Human</th>
<th>Machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>PII, Trust, Safety</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Transmission costs</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Client-side performance</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Server-side performance</td>
<td></td>
<td>Y</td>
</tr>
</tbody>
</table>
Granularity, Fidelity, Accuracy

- 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

- Trends, Defect Reports
- Engineering Activity, Benchmarking, Testing
- Extrapolation

Past

Information

- What’s happened? (Reporting)
- What’s happening now? (Alerts)
- What will happen? (Forecasting)

Insight

- How and why did it happen? (Factor analysis)
- What is the next best action? (Recommendation)
- What’s the best/worst that can happen? (Modeling / Simulation)

Future

- Software quality models, bottleneck analysis
- Specification refinement, asset reallocation
- Failure prediction models

<table>
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<tr>
<th>Quotes from medical articles</th>
<th>Possible applications to testing software</th>
</tr>
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<tbody>
<tr>
<td>“High Value Care improves health, avoids harms, and eliminates wasteful practices.”</td>
<td>Better testing improves the health of the software and the team, avoids harm and eliminates wasteful practices.</td>
</tr>
</tbody>
</table>
“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

[2] Perhaps can we learn from medicine...
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<tbody>
<tr>
<td>“The Smart Testing series examines scenarios in which diagnostic tests are commonly ordered in the absence of supporting data. The articles use evidence-based recommendations to clarify when testing is appropriate. Authors are encouraged to include specific examples of testing that may be excessive or harmful.”</td>
<td>Evidence of the results of our testing, including assessments and retrospectives can help improve our testing. Focus, also, on discouraging testing that may be excessive or harmful.</td>
</tr>
</tbody>
</table>

http://www.ccjm.org/corporate-links/journal-info/instructions/smart-testing-instructions.html

[3] Perhaps can we learn from medicine...
<table>
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</tr>
</thead>
<tbody>
<tr>
<td>“ACP defines High Value Care as the delivery of services providing benefits that make their harms and costs worthwhile. Value is not merely cost.”</td>
<td>Only embark on implementing and using stuff where the benefits far outweigh the potential harms and costs.</td>
</tr>
</tbody>
</table>

"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-careunnecessary-imaging-procedures-and-diagnostic
WHAT NEXT?

Helping you to get started...
READ THIS BOOK 😊

The Mobile Analytics Playbook: A practical guide to better testing

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

Google Analytics for Android https://classroom.udacity.com/courses/ud876-2/
https://github.com/udacity/Analytics_and_Tag_Manager