

Comparing Apples to Androids

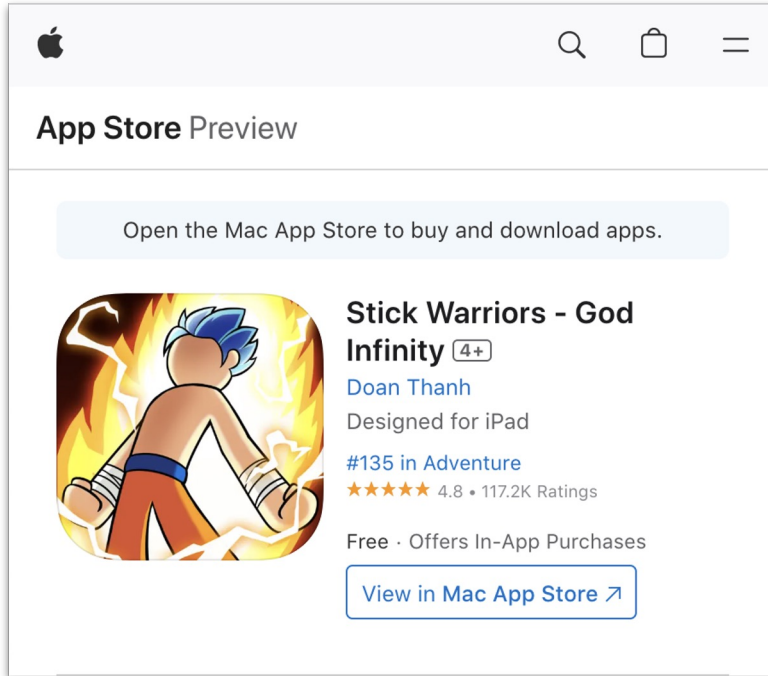
Discovery, Retrieval, and Matching of iOS and Android Apps for Cross-Platform Analyses

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Magdalena Steinböck | magdalena.steinboeck@seclab.wien
TU Wien, Vienna, Austria


Lisbon April 15th, 2024



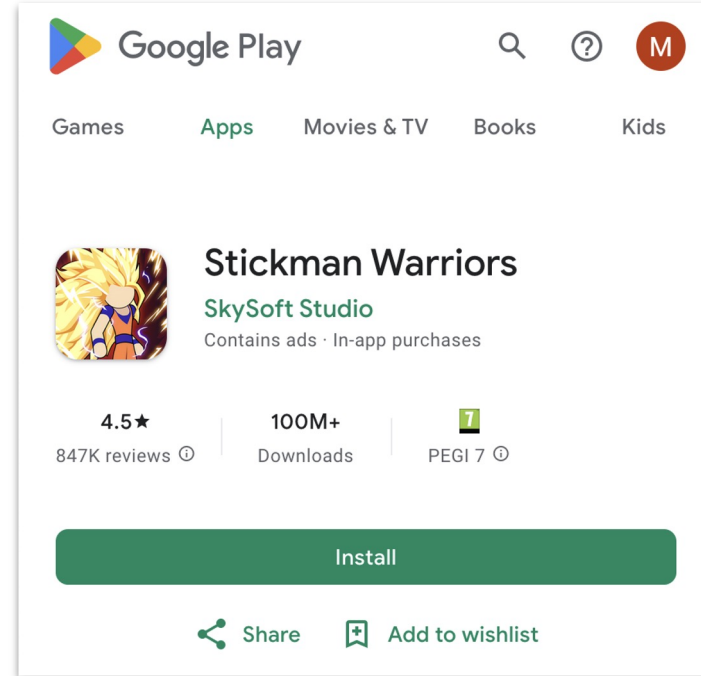
Motivation



Open the Mac App Store to buy and download apps.




Stick Warriors - God Infinity 4+
Doan Thanh
Designed for iPad
#135 in Adventure
★★★★★ 4.8 • 117.2K Ratings
Free · Offers In-App Purchases
[View in Mac App Store](#)



Google Play

Games Apps Movies & TV Books Kids



Stickman Warriors
SkySoft Studio
Contains ads · In-app purchases

4.5★
847K reviews ⓘ

100M+
Downloads

7
PEGI 7 ⓘ

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App Stores




What does "same" mean?



App Store Preview


This app is available only on the App Store for iPhone, iPad, and Apple Watch.



Google Maps (4+)
 Places, Navigation & Traffic
 Google LLC
 #1 in Navigation
 ★★★★★ 4.7 • 5.8M Ratings
 Free


iPhone Screenshots

Never miss a turn
 Get real-time traffic updates



Additional Screenshots

Google Play



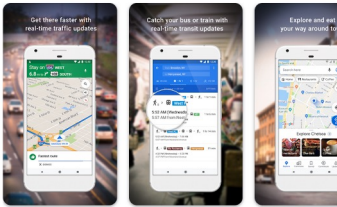
Google Maps
 Google LLC
 Contains ads

4.0★ | 10B+ Downloads | Everyone

17.7M reviews

Install

Share | Add to wishlist



About this app

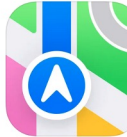
Navigate your world faster and easier with Google Maps. Over 220 countries and territories mapped and hundreds of millions of businesses and places on the

Games | Apps | Movies &... | Books | Kids

VS.

App Store Preview

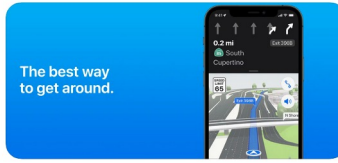
This app is available only on the App Store for iPhone, iPad, and Apple Watch.



Apple Maps (4+)
 Navigate and explore the world
 Apple
 ★★★★★ 2.7 • 23.4K Ratings
 Free

iPhone Screenshots

The best way to get around.




Additional Screenshots
 iPad, Apple Watch

Maps

Apple Maps is the best way to navigate and explore the world - all with your privacy protected.

more

Google Play



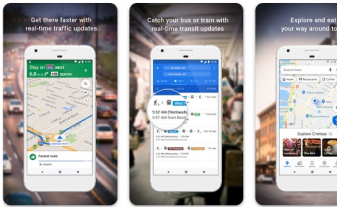
Google Maps
 Google LLC
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4.0★ | 10B+ Downloads | Everyone

17.7M reviews

Install

Share | Add to wishlist



About this app

Navigate your world faster and easier with Google Maps. Over 220 countries and territories mapped and hundreds of millions of businesses and places on the

Games | Apps | Movies &... | Books | Kids

What does “same” mean?

“Comparing Apples to Oranges” Problem




What does "same" mean?



App Store Preview


This app is available only on the App Store for iPhone, iPad, and Apple Watch.



Google Maps (4+)
 Places, Navigation & Traffic
 Google LLC
 #1 in Navigation
 ★★★★★ 4.7 • 1.1M Ratings
 Free

iPhone Screenshots


Never miss a turn
 Get real-time traffic updates



Additional Screenshots

same

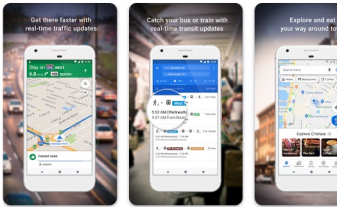
Google Play



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 Contains ads
 1.1M reviews 10B+ Downloads Everyone

Install

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 iPad, Apple Watch


Maps

Apple Maps is the best way to navigate and explore the world - all with your privacy protected.

more

different

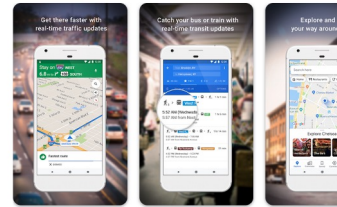
Google Play



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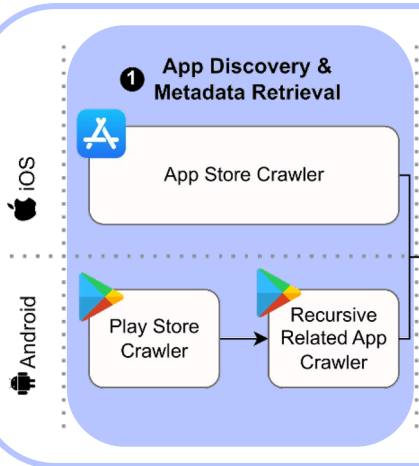
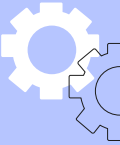


About this app

Navigate your world faster and easier with Google Maps. Over 220 countries and territories mapped and hundreds of millions of businesses and places on the

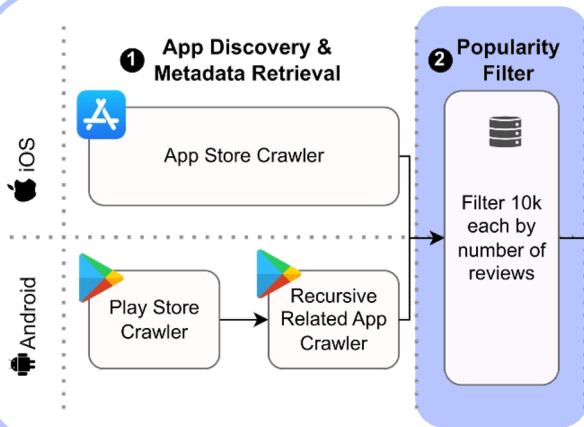
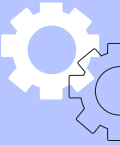
Games Apps Movies &... Books Kids

Architecture



- Discover Apps
- Download Metadata

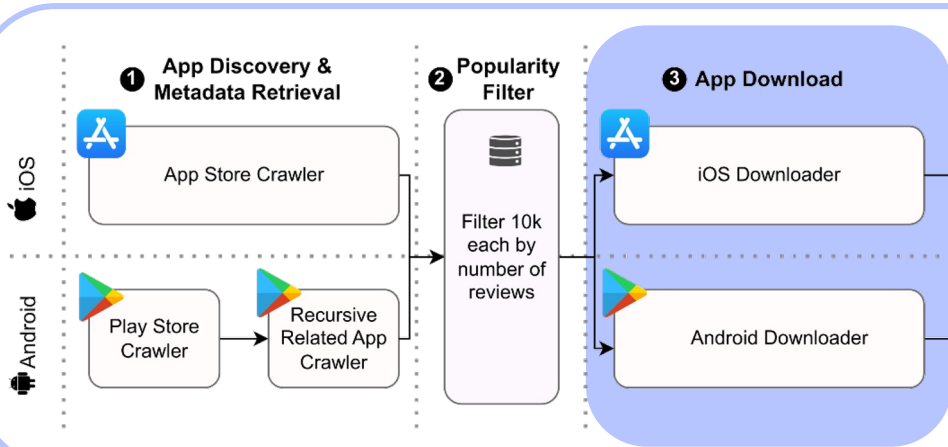
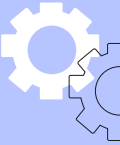
Architecture



- Get all free apps
- Sort them by their number of user ratings (desc.)
- Get first 10k apps for Android and iOS

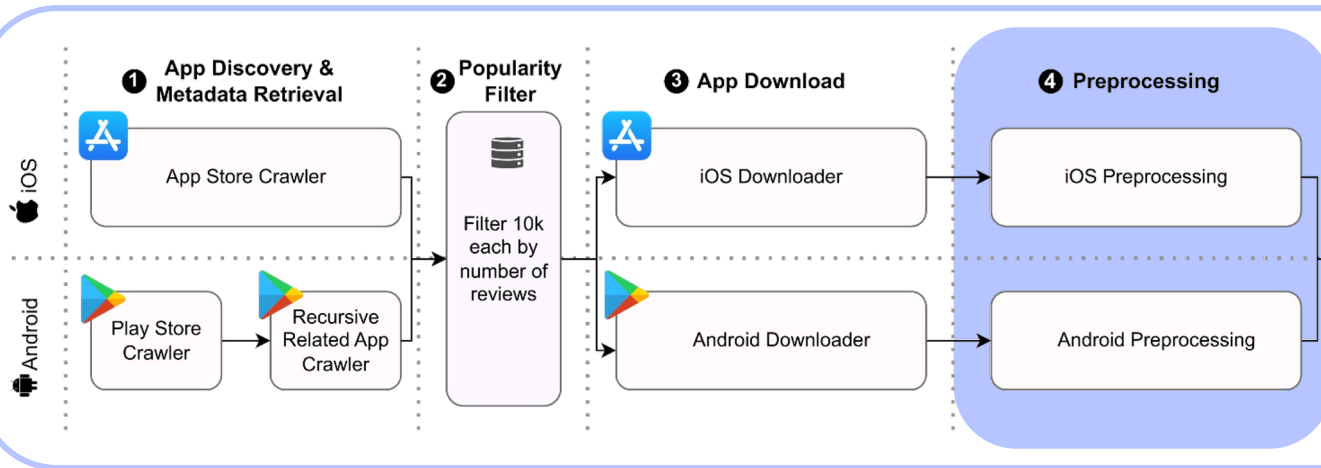
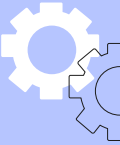


Architecture



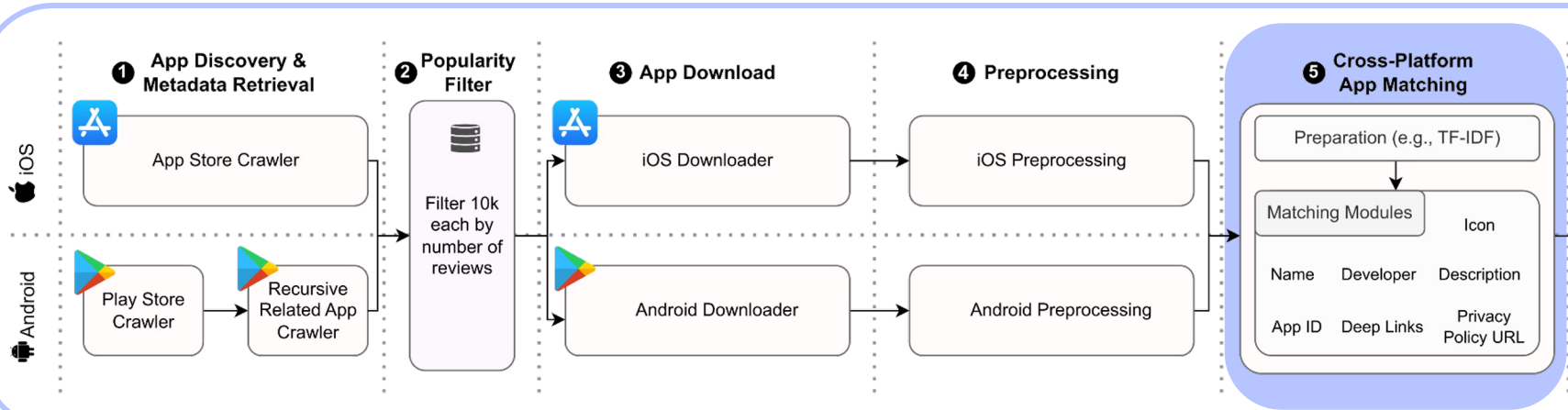
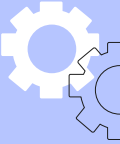
- Download Apps
- Download Metadata (again)

Architecture



- Perform preprocessing steps for each app

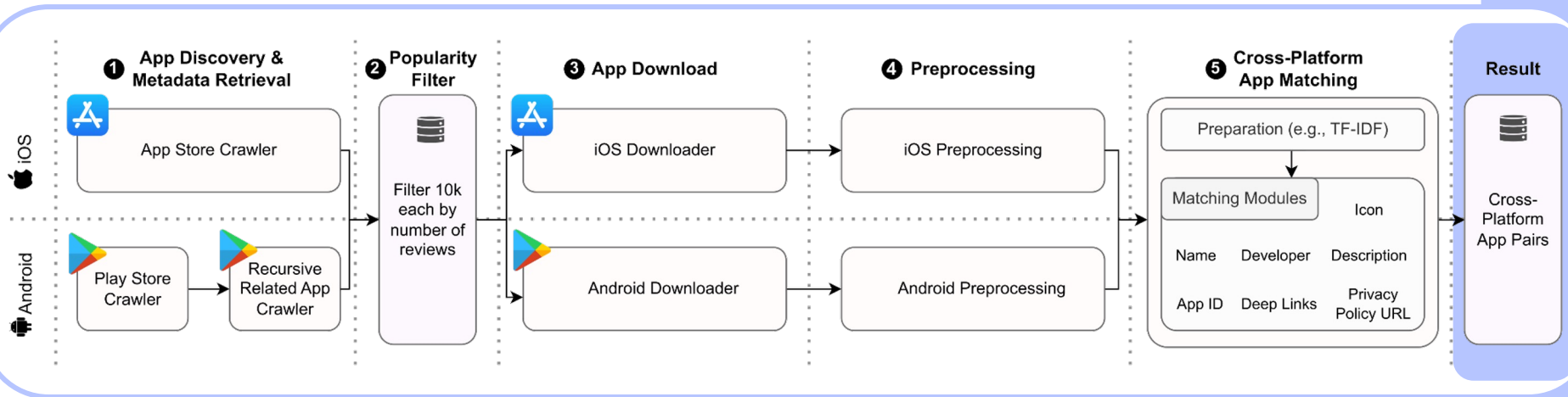
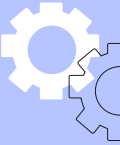
Architecture



Match each iOS app with each Android app

- Preparation
- Matching
- Scoring

Architecture



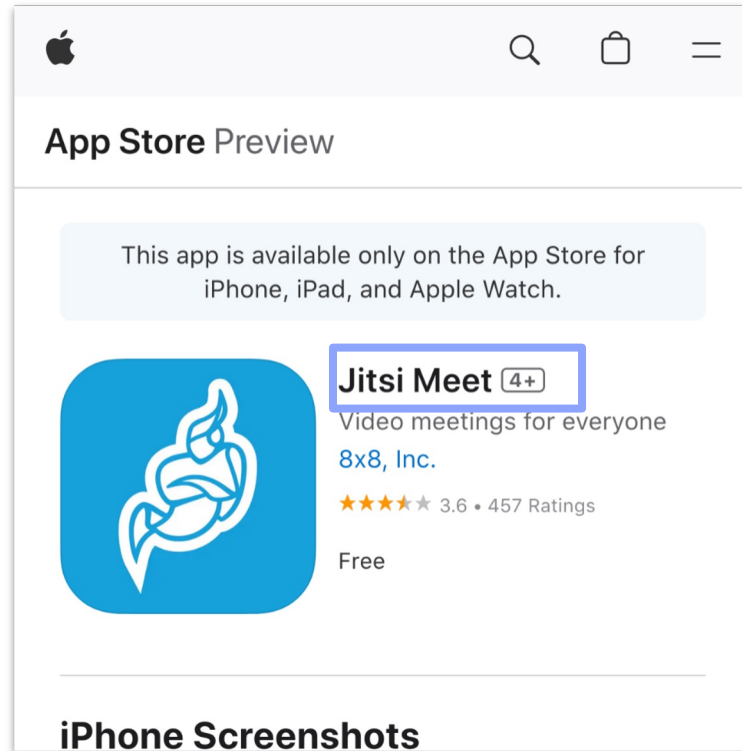
Perform aggregation to get

- For each iOS app
- The Android app with the highest average matching score



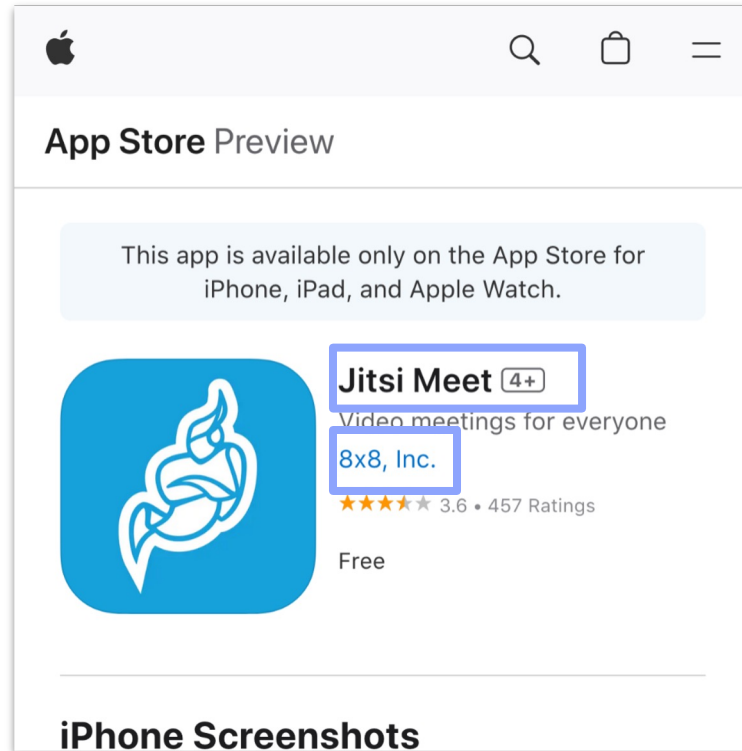
Matching Details

- App Name



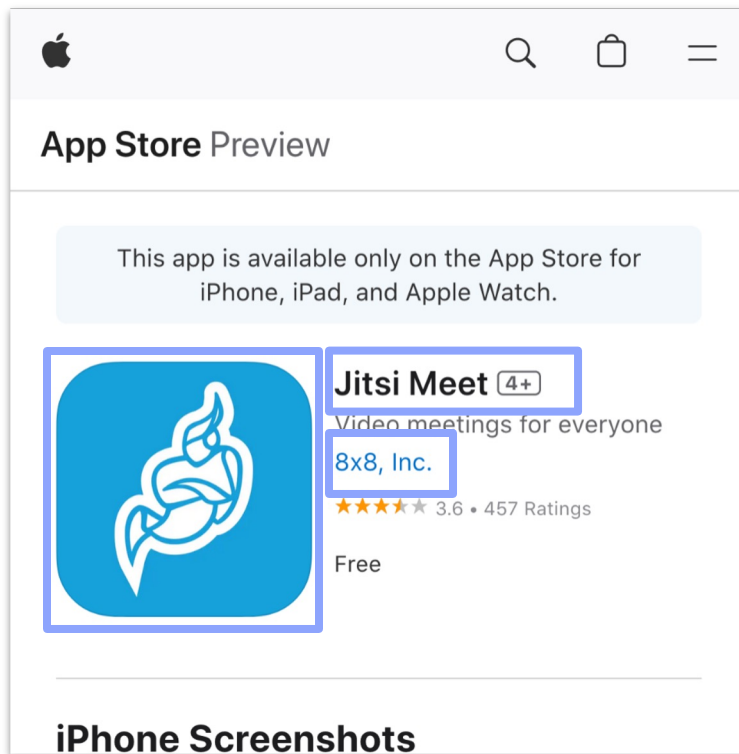
Matching Details

- App Name
- Developer Name



Matching Details

- App Name
- Developer Name
- App Icon



Matching Details

- **App Name**
- **Developer Name**
- **App Icon**
- **App Description**

iPad, Apple Watch

Jitsi Meet lets you stay in touch with all your teams, be they family, friends, or colleagues. Instant video conferences, efficiently adapting to your scale.

* Unlimited users: There are no artificial restrictions on the number of users or conference participants. Server power and bandwidth are the only limiting factors.

* No account needed.

* Lock-protected rooms: Control the access to your conferences with a password.

* Encrypted by default.

* High quality: Audio and video are delivered with the clarity and richness of Opus and VP8.

* Web browser ready: No downloads are required of your friends to join the conversation. Jitsi Meet works directly within their browsers as well. Simply share your conference URL with others to get started.

* 100% open source: Powered by awesome communities

Matching Details

- **App Name**
- **Developer Name**
- **App Icon**
- **App Description**
- **Privacy Policy URL**

Apple Watch

Requires watchOS 4.0 or later.

Languages

English

Age Rating

4+

Copyright

© 2018-present 8x8, Inc.

Price

Free

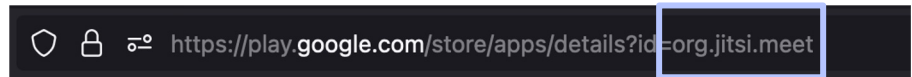
[App Support ↗](#)

[Privacy Policy ↗](#)



Matching Details

- App Name
- Developer Name
- App Icon
- App Description
- Privacy Policy URL
- App ID



Matching Details

- App Name
- Developer Name
- App Icon
- App Description
- Privacy Policy URL
- App ID
- Deep Links

org.jitsi.meet://main

Diese Seite in „Jitsi Meet“ öffnen?

Abbrechen Öffnen

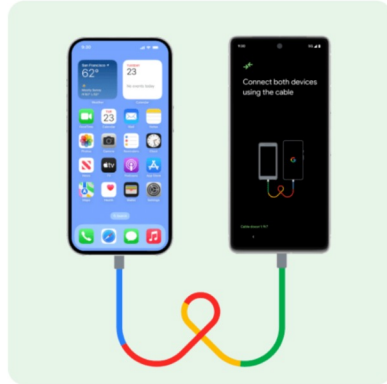
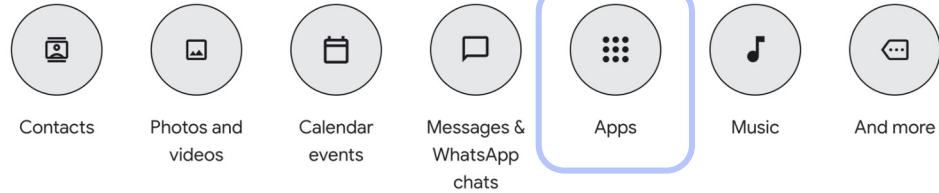


Results

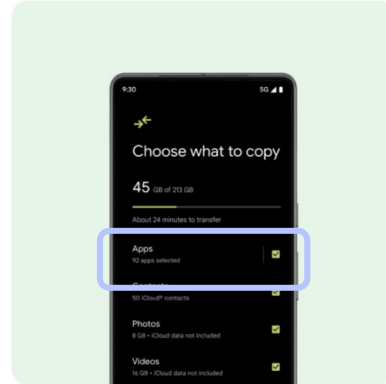
9,943 iOS apps x 9,942 Android apps

≈ 100,000,000 comparisons

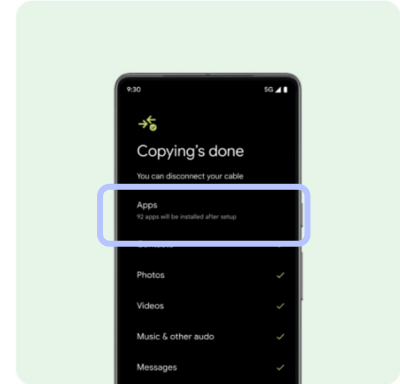
Google Migration API



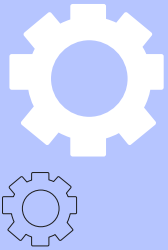
1. Connect both devices.



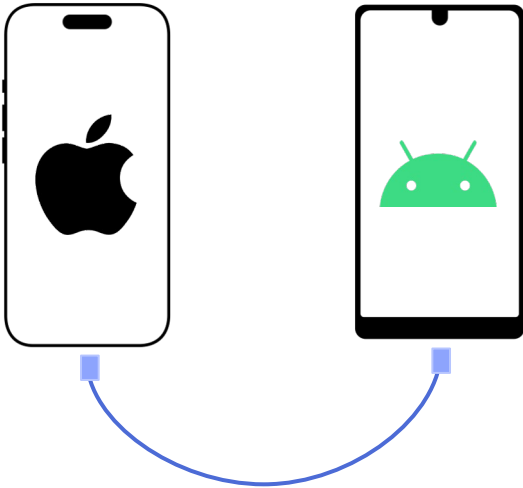
2. Select your data.



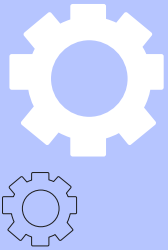
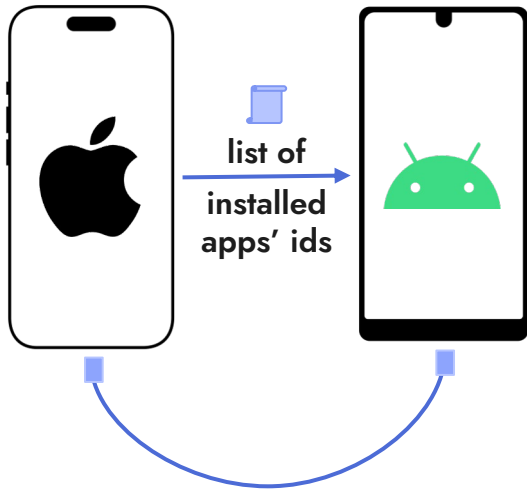
3. Transfer.



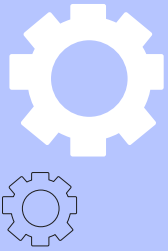
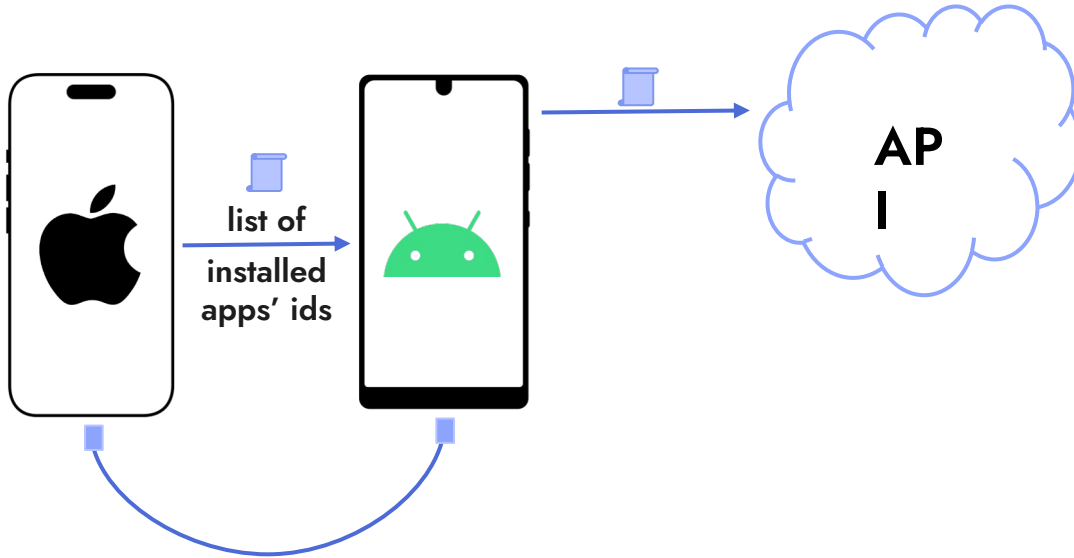
Google Migration API



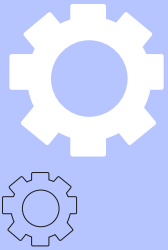
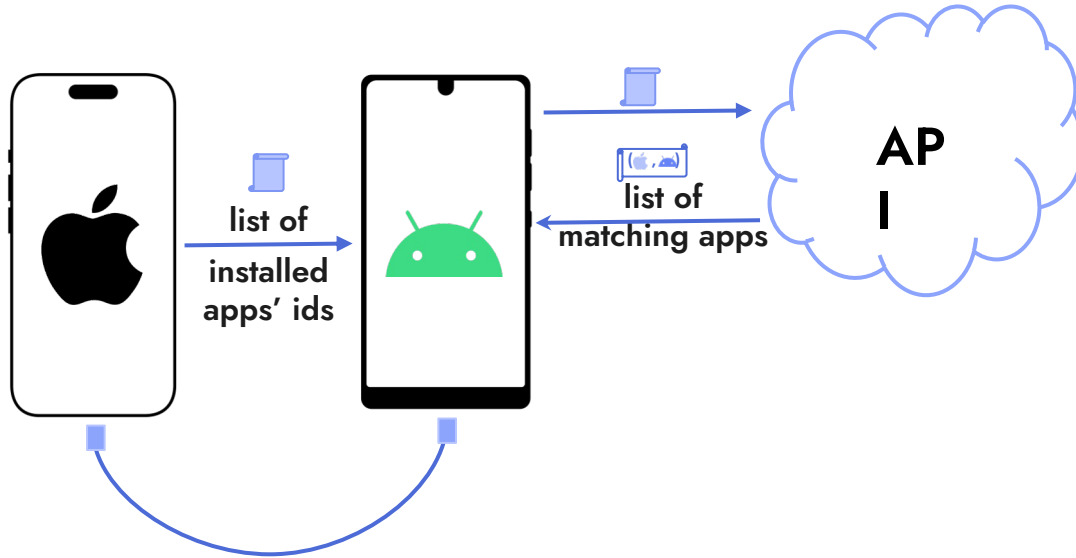
Google Migration API



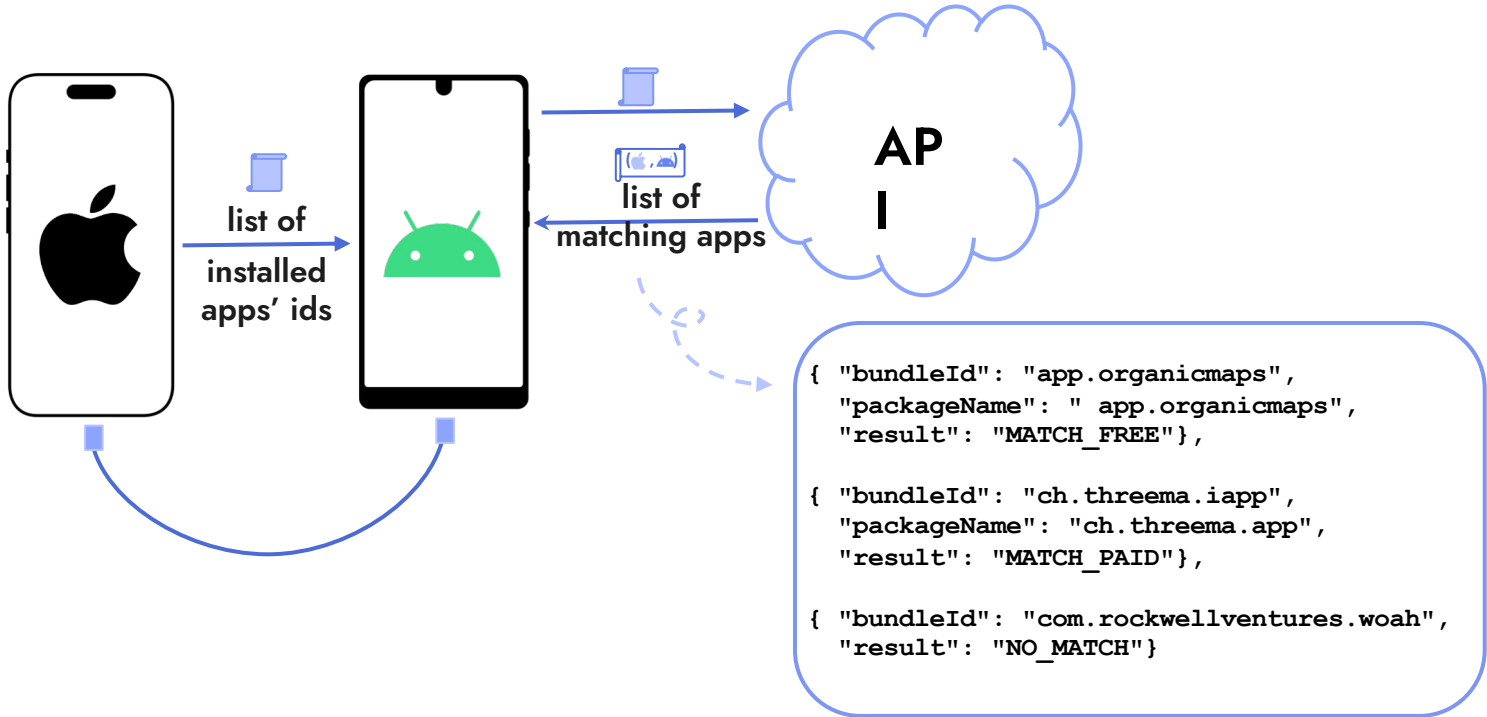
Google Migration API



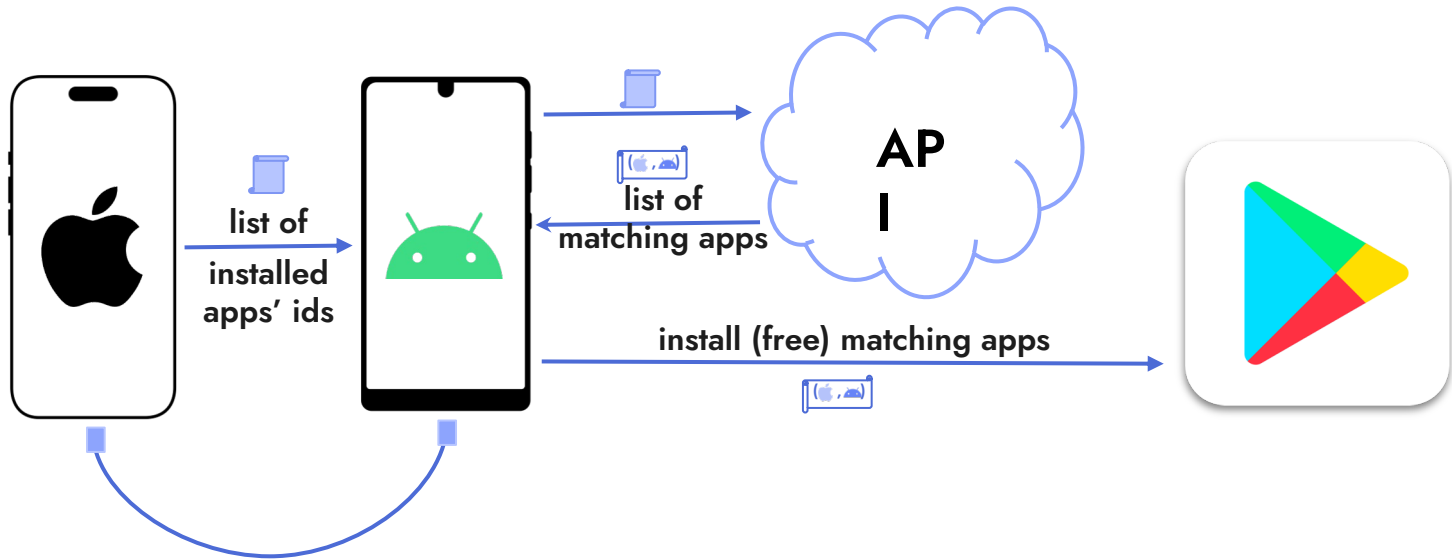
Google Migration API



Google Migration API



Google Migration API



Results

9,943 iOS apps x 9,942 Android apps

≈ 100,000,000 comparisons

Results

9,943 iOS apps x 9,942 Android apps

≈ 100,000,000 comparisons

Mapping of 1 iOS app to 1 Android app
9,943 app pairs



Validation against reference pairs (RP) obtained from Google Migration API

Dataset

iOS



Android



Dataset

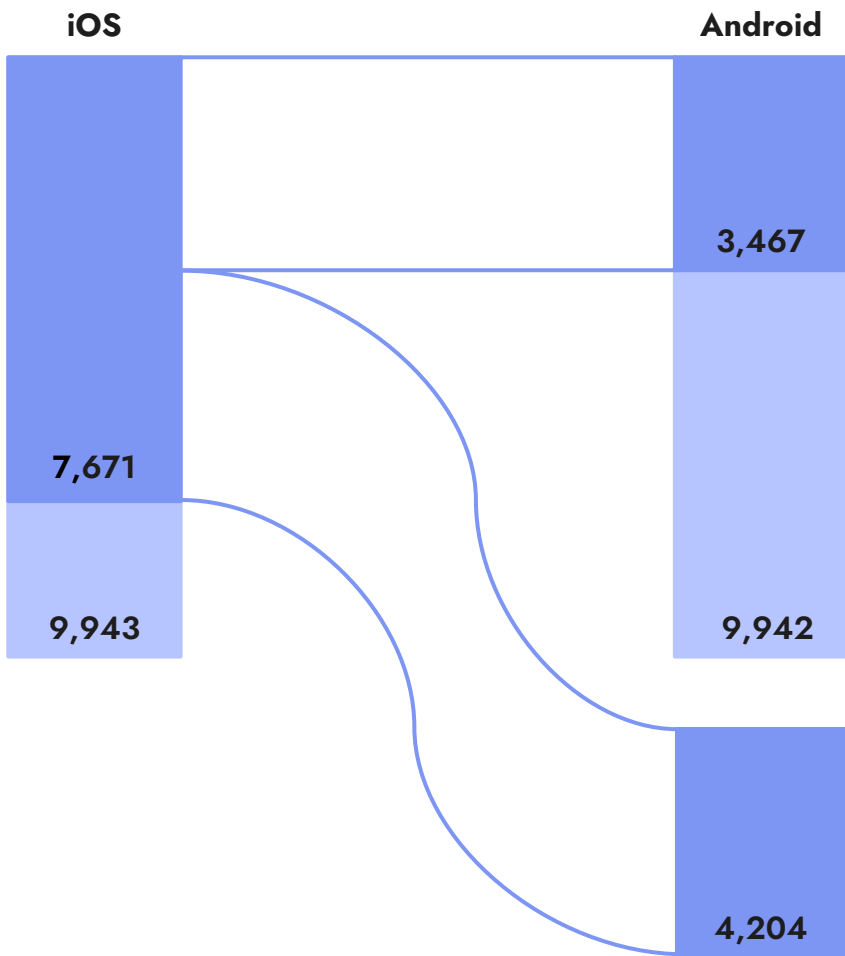
iOS



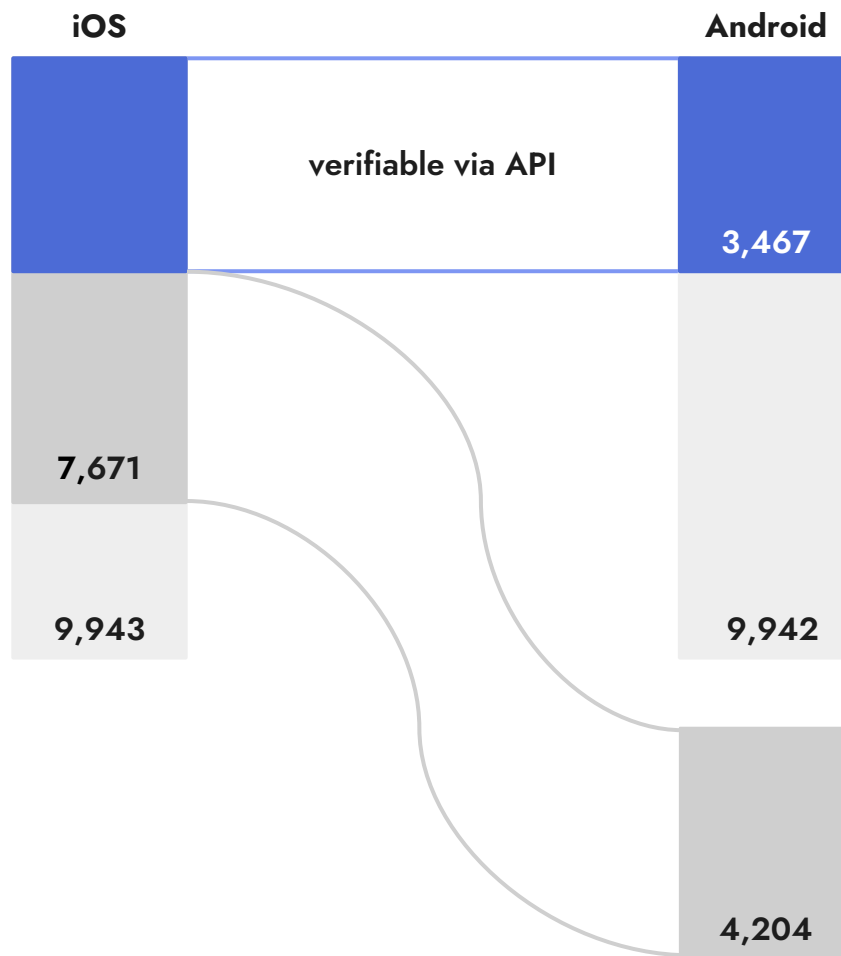
Android



Dataset



Dataset



Results

Approach	TP (%)	FP (%)	FN (%)
<i>Our Approach</i>	3,322 (95.82 %)	14 (0.40 %)	131 (3.78 %)

Comparison to previous Research

Approach	TP (%)	FP (%)	FN (%)
<i>Our Approach</i>	3,322 (95.82 %)	14 (0.40 %)	131 (3.78 %)
Hu et al. [1]	2,908 (83.88 %)	303 (8.74 %)	256 (7.38 %)
Kollnig et al. [2]	1,781 (51.37 %)	403 (11.62 %)	1,283 (37.01 %)
Ali et al. [3]	588 (16.96 %)	0 (0.00 %)	2,079 (59.97 %)
Han et al. [4]	514 (14.83 %)	0 (0.00 %)	2,953 (85.17 %)



Check out our Code!



- High matching rate
- Fast
- Modular

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Feature Ablation Study

Feature (Sub)Set	TP (%)	FP (%)	FN (%)
All seven features	3,322 (95.82 %)	14 (0.40 %)	131 (3.78 %)
w/o Deep Links	3,391 (97.81 %)	27 (0.78 %)	49 (1.41 %)
w/o Developer Name	3,341 (96.37 %)	18 (0.52 %)	108 (3.12 %)
w/o Description	3,279 (94.58 %)	36 (1.04 %)	152 (4.38 %)
w/o App Name	3,258 (93.97 %)	35 (1.01 %)	174 (5.02 %)
w/o App ID	3,250 (93.74 %)	19 (0.55 %)	198 (5.71 %)
w/o Privacy URL	3,206 (92.47 %)	7 (0.20 %)	254 (7.33 %)
w/o App Icon	3,173 (91.52 %)	20 (0.58 %)	274 (7.90 %)