Mobile app privacy analysis

An overview of methods and results

TECH mobile app audit expert exchange meeting

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- PhD candidate at the Institute for Application Security @ TUBS.
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Benni (he/him)

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- Has studied computer science.
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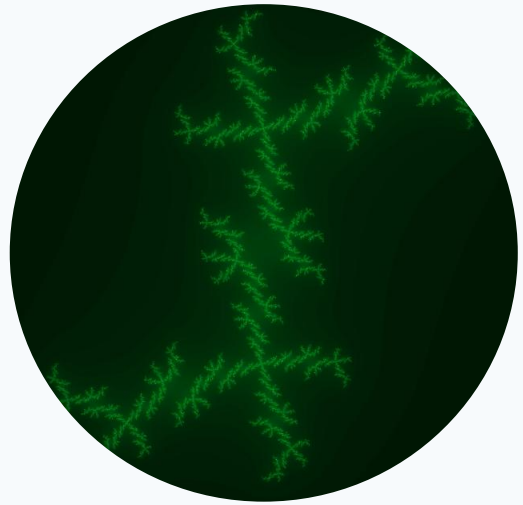

Lorenz (he/him)

Chairperson Datenanfragen.de e. V.

- Student of physics.
- Thinks that actual data protection necessitates a system transformation.

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We represent Datenanfragen.de e. V.,
a German non-profit association
that has made it its mission
to help people exercise their
right to data protection.

PoPETs Proceedings on Privacy Enhancing Technologies ; 2022 (4):486–506

Simon Koch*, Malte Wessels, Benjamin Altpeter, Madita Olvermann, and Martin Johns

Keeping Privacy Labels Honest

Abstract: At the end of 2020, Apple introduced privacy nutritional labels, requiring app developers to state what data is collected by their apps and for what purpose. In this paper, we take an in-depth look at the privacy labels and how they relate to actual transmitted data.

First, we give an exploratory statistically evaluation of 11074 distinct apps across 22 categories and their corresponding privacy label or lack thereof. Our dataset shows that only some apps provide privacy labels, and a small number self-declare that they do not collect any data. Additionally, our statistical methods showcase the differences of the privacy labels across application categories.

We then select a subset of 1687 apps across 22 categories from the German App Store to conduct a no-touch traffic collection study. We analyse the traffic against a set of 18 honey-data points and a list of known advertisement and tracking domains. At least 276 of these apps violate their privacy label by transmitting data without declaration, showing that the privacy labels' correctness was not validated during the app approval process. In addition, we evaluate the apps' adherence to the GDPR in respect of providing a privacy consent form, through collected screenshots, and identify numerous potential violations of the directive.

Keywords: Smartphones, iOS, Apple, GDPR, Privacy, Privacy Labels

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1 Introduction

Smartphones are ubiquitous [16], and ever more services rely on smartphone ownership, e.g., in the forms of banking apps or messaging application. Smartphones are carried everywhere and have become part of our day-to-day clothing. They carry data that provides deep insights into our private life, including our contacts, pictures, browsing behavior, and where we spend our time.

Contacts and contact interaction provide information about who is in our social network and possibly on the types of relationships between us [22, 43]. As most current smartphones include GPS and a myriad of other sensors, they observe and record where we go every day and for how long we stay [37, 47]. Finally, any tokens that are unique to a user can cross-identify a user across different data collectors. Combining identifying tokens with privacy-sensitive data presents a huge threat for the smartphone user's privacy.

Privacy is heavily contested. The EU introduced the GDPR law in 2016, and made it mandatory in 2018 [12]. This law requires that a user has to explicitly agree to any personal data collection, in the context of an app, that is not necessary to provide a service or that the service provider has no legitimate interest for. However, the required changes to applications are not always effected, and the industry keeps collecting our data regardless [1].

Apple positions privacy among the company's core values, so they 'design Apple products to protect [users'] privacy and give [them] control over [their] information' [5]. Part of their privacy protection mechanism is asking app developers to specify their data usage practices via 'Privacy Nutrition Labels' (short: privacy labels) [3, 8].

Privacy labels are a method of displaying how an application collects and uses data [32]. They have been shown to impact users' awareness of privacy in the con-

https://petsymposium.org/popets/2022/popets-2022-0119.pdf

datarequests.org

Worrying confessions: A look at data safety labels on Android

The Google Play Store recently introduced a data safety section in order to give users accessible insights into apps' data collection practices. We analyzed the labels of 43,927 popular apps. Almost one third of the apps with a label claims not to collect any data. But we also saw often downloaded apps, including apps meant for children, admitting to collecting and sharing highly sensitive data like the user's sexual orientation or health information for tracking and advertising purposes. To verify the declarations, we recorded the network traffic of 500 apps, finding more than one quarter of them transmitting tracking data not declared in their data safety label.

At the end of April 2022, Google launched their new *data safety* section for Android apps, a feature meant to give users reliable information about how apps distributed through the Play Store handle their users' data.

https://www.datarequests.org/blog/android-data-safety-labels-analysis/

The OK Is Not Enough: A Large Scale Study of Consent Dialogs in Smartphone Applications

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Abstract

Mobile applications leaking personal information is a well established observation pre and post GDPR. The legal requirements for personal data collection in the context of tracking are specified by GDPR and the common understanding is, that tracking must be based on proper consent. Studies of the consent dialogs on websites revealed severe issues including dark patterns. However, the mobile space is currently underexplored with initial observations pointing towards a similar state of affairs. To address this research gap we analyze a subset of possible consent dialogs, namely privacy consent dialogs, in 3006 Android and 1773 iOS applications. We show that 22.3% of all apps have any form of dialog with only

be voluntary and must not be coerced. Recent fines for Meta by the Irish Data Protection Commission do underline this principle [6].

Studies analyzing cookie consent dialogs on the web revealed that a large portion do not conform to the stated rules. Even worse, the analyzed dialogs widely employed stylistic choices to coerce or nudge a user towards giving consent [54, 55, 60, 71]. Such design choices have been termed 'Dark Patterns'. The overwhelming presence of Dark Patterns in consent dialogs led to the European privacy advocacy NGO *noyb*[1] launching two campaigns against deceptive cookie banners [16, 18] resulting in websites changing their dialog designs. This shows that effort towards the study of consent

https://www.usenix.org/system/files/sec23fall-prepub-215-koch.pdf

Previous results

Photo adapted after: “clear plastic bottle on table” by National Cancer Institute (Unsplash license)

Privacy labels

App stores require developers to disclose privacy practices. Supposed to allow users an informed decision on which app to choose.

App Privacy

See Details

The developer, **Meta Platforms, Inc.**, indicated that the app's privacy practices may include handling of data as described below. For more information, see the developer's privacy policy.

Data Used to Track You

The following data may be used to track you across apps and websites owned by other companies:

- Contact Info
- Identifiers
- Other Data

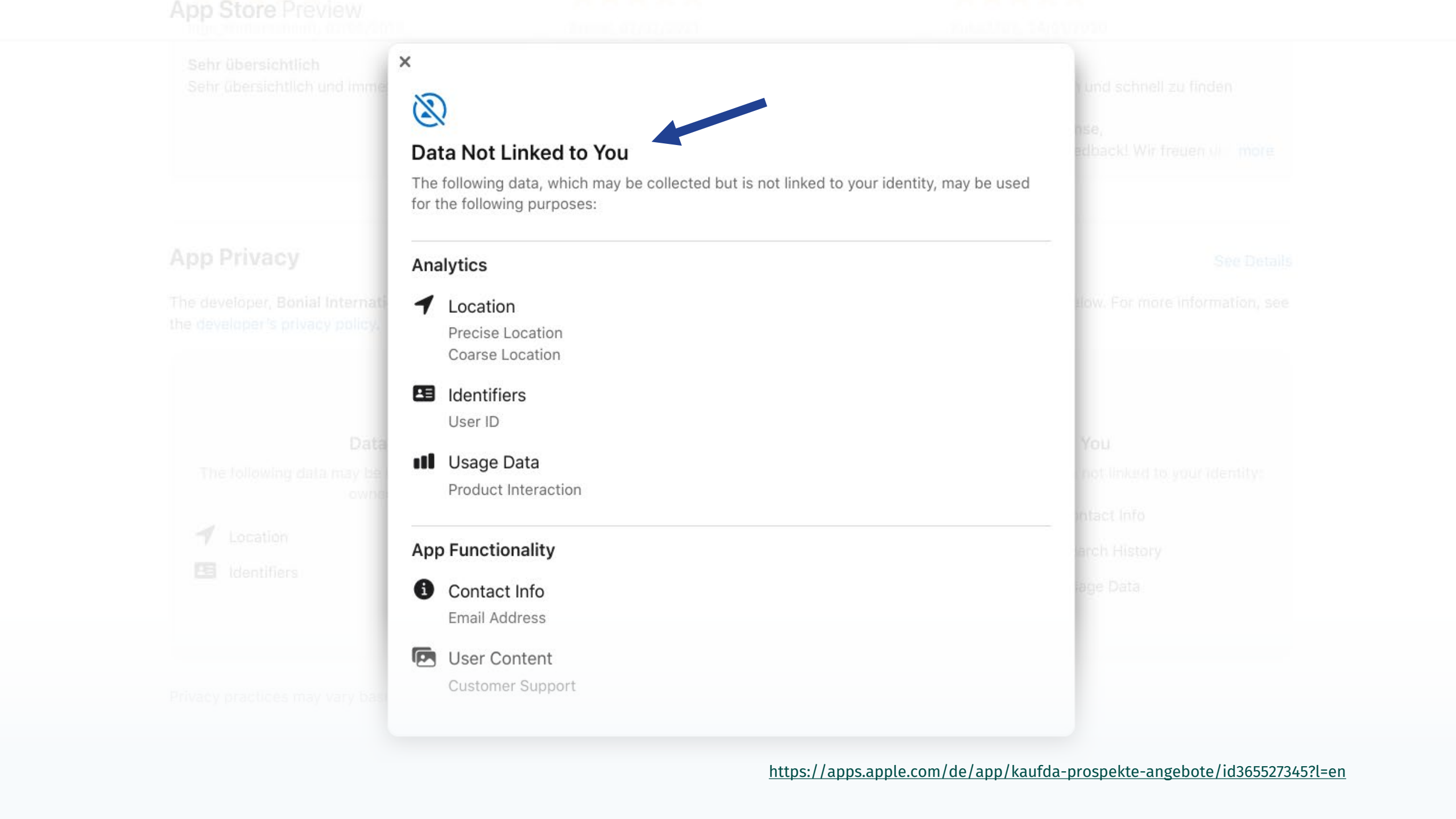
Data Linked to You

The following data may be collected and linked to your identity:

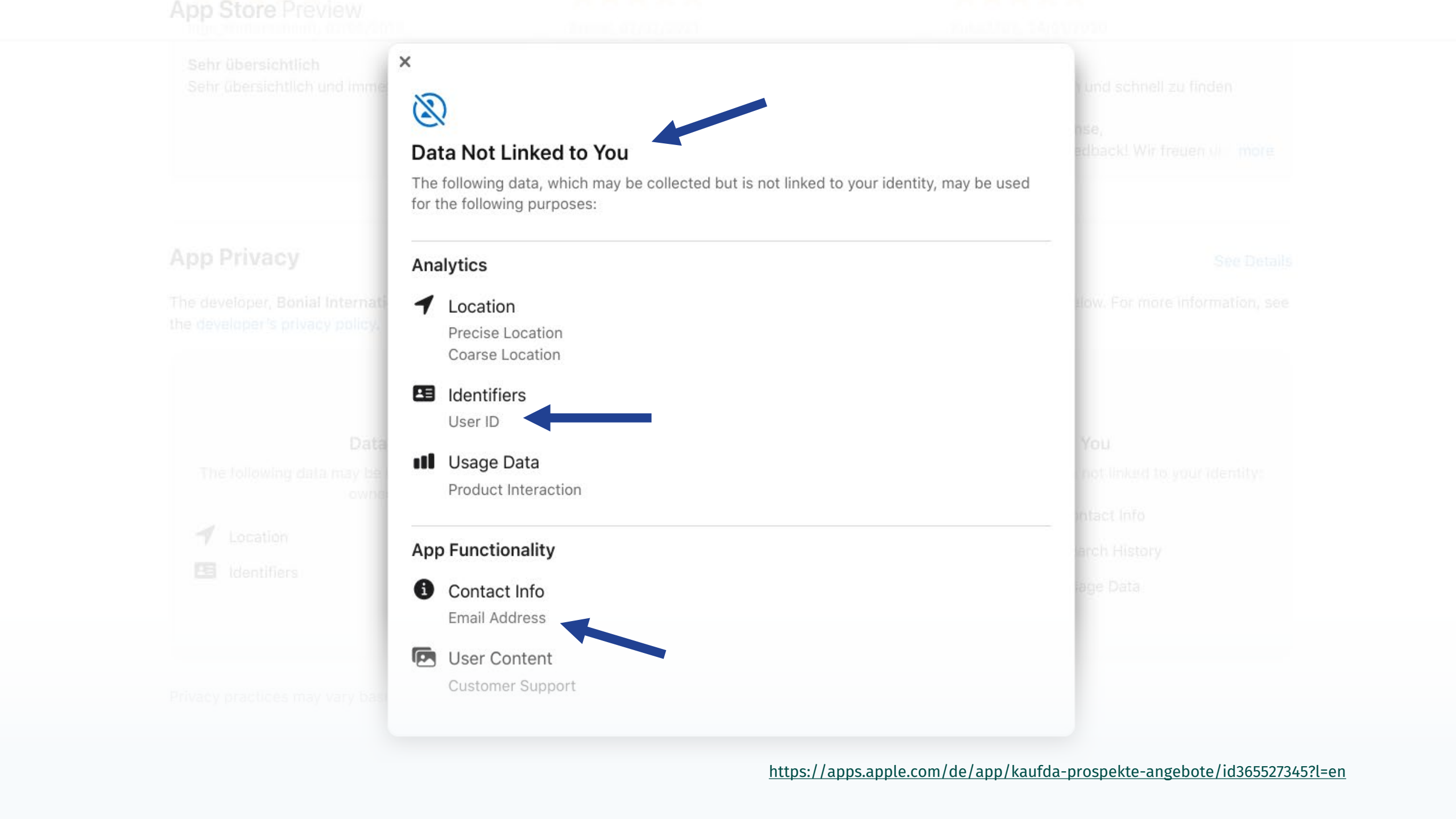
- Health & Fitness
- Financial Info
- Contact Info
- User Content
- Browsing History
- Usage Data
- Diagnostics
- Purchases
- Location
- Contacts
- Search History
- Identifiers
- Sensitive Info
- Other Data

Privacy practices may vary, for example, based on the features you use or your age. Learn More

https://apps.apple.com/us/app/facebook/id284882215



https://apps.apple.com/de/app/kaufda-prospekte-angebote/id365527345?l=en



https://apps.apple.com/de/app/kaufda-prospekte-angebote/id365527345?l=en

16 % of analysed iOS apps (1,687) transmitted data not declared in their label.

Data safety →

Safety starts with understanding how developers collect and share your data. Data privacy and security practices may vary based on your use, region, and age. The developer provided this information and may update it over time.

This app may share these data types with third parties
Location, Personal info and 7 others

This app may collect these data types
Location, Personal info and 10 others

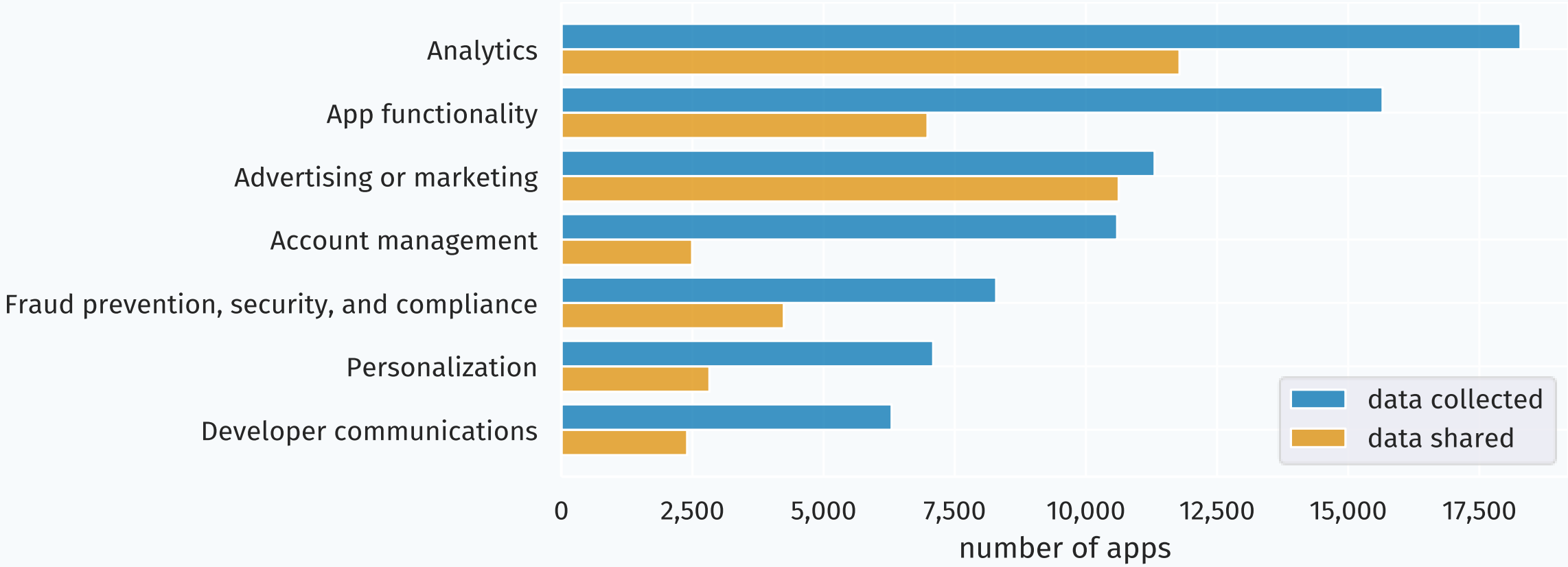
Data is encrypted in transit

You can request that data be deleted

See details

Ratings and reviews →

https://play.google.com/store/apps/details?id=com.amazon.mShop.android.shopping



Number of apps that collect and/or share the data for the respective purposes according to their data safety label.

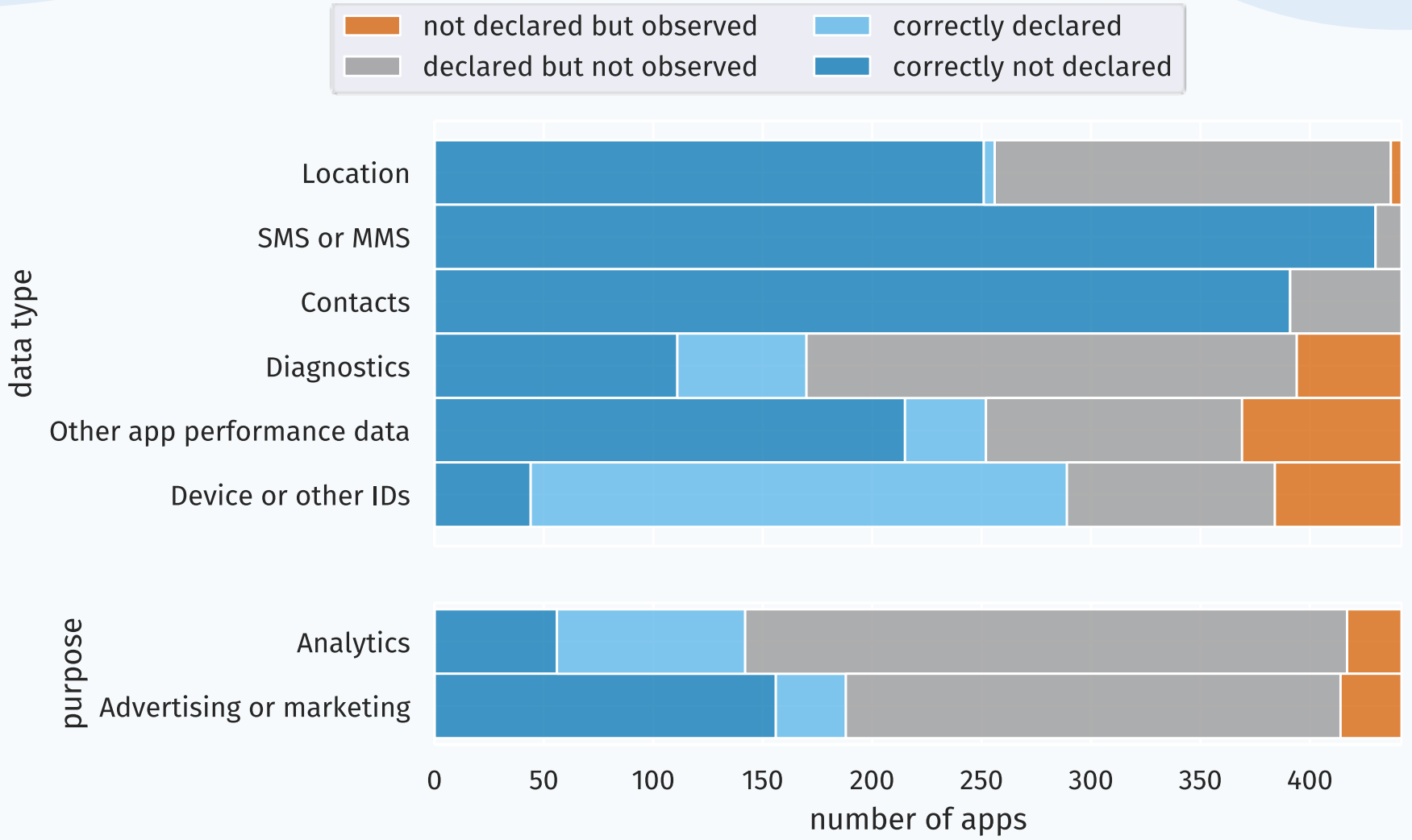
Worrying confessions

While looking at the data safety labels, we noticed a worrying number of apps declaring that they collect or even share highly sensitive data including information about their user's sexual orientation, political or religious beliefs, and health for tracking or advertising purposes. Remember that these are self-declarations by the app developers, not allegations by us or third parties. The app developers themselves seem to have no problem with admitting to this incredibly problematic data use.

Here are just a few examples of well-known apps with many downloads doing this[3]:

- Facebook collects political or religious beliefs, the sexual orientation, and health info for analytics purposes
- Amazon Shopping collects health info for analytics purposes
- Roblox collects the sexual orientation for analytics purposes and shares it for analytics, and advertising or marketing purposes
- SoundCloud: Play Music & Songs shares the sexual orientation for advertising or marketing purposes
- My Little Pony: Magic Princess collects the sexual orientation for analytics, and advertising or marketing purposes and shares it for advertising or marketing purposes
- FarmVille 2: Country Escape collects the sexual orientation for advertising or marketing purposes
- 9GAG: Funny GIF, Meme & Video shares the sexual orientation for analytics purposes
- Zalando Lounge - Shopping Club collects and shares the sexual orientation for analytics, and advertising or marketing purposes
- momox: Bücher & mehr verkaufen collects and shares the sexual orientation for advertising or marketing purposes
- nebenan.de - your social network for neighbours collects the sexual orientation for advertising or marketing purposes

https://www.datarequests.org/blog/android-data-safety-labels-analysis/



Evaluation of the correctness of the data types and purposes in the analysed data safety labels.
Remember that we can only definitively say when data is collected but can't confirm that it is never collected.

Tracking data transmissions

Looking at which trackers are contacted by apps and what data is sent to them.

7. Results

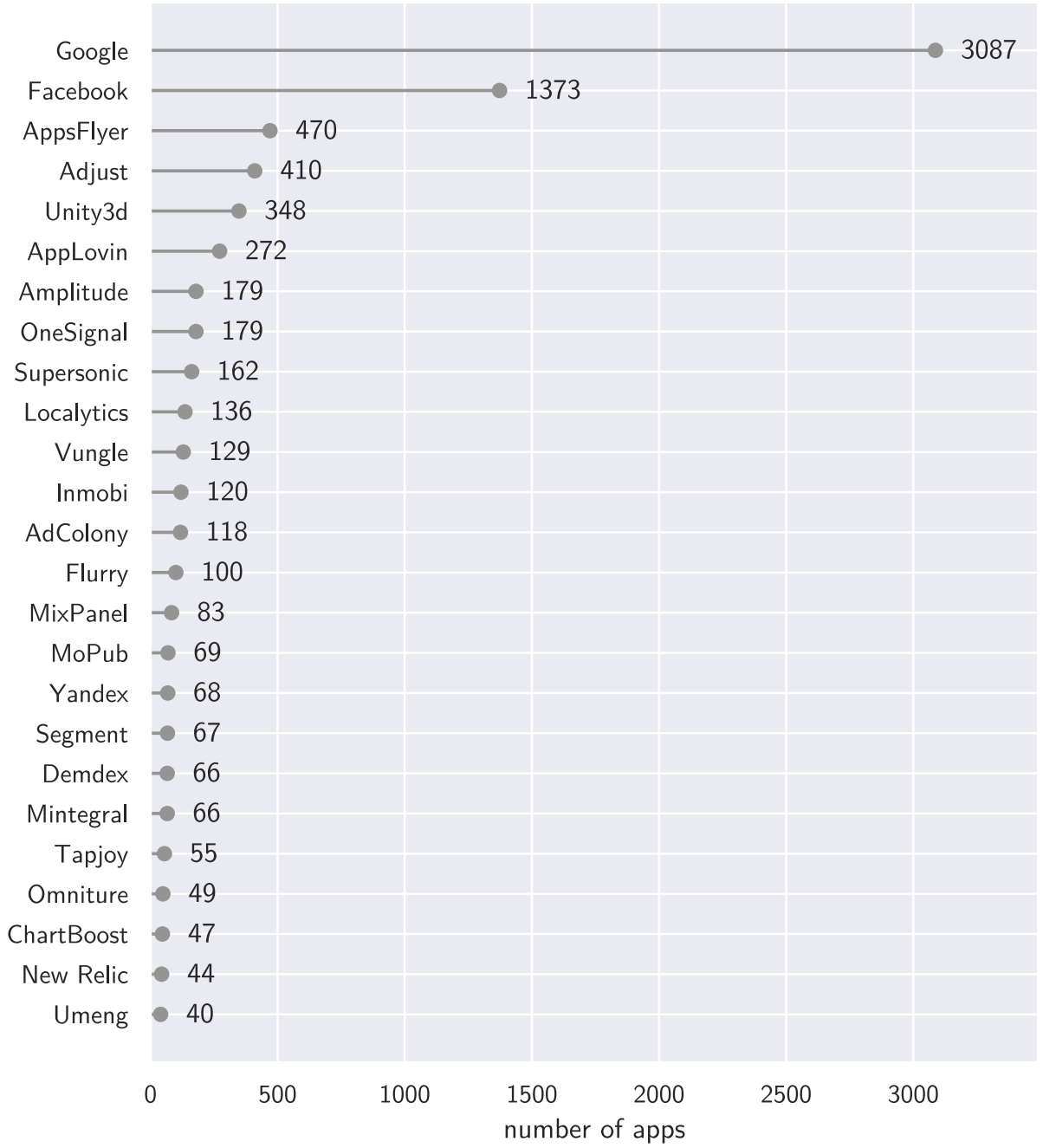
We successfully analysed 4,388 apps with 2,068 apps on Android and 2,320 apps on iOS, corresponding to 62.42 % and 93.51 % of the downloaded apps, respectively. On Android, the high number of apps we could not analyse is caused for the most part by problems with the certificate pinning bypass through objection. 1,049 of the Android apps failed to launch or quit immediately after being launched through objection. These apps were excluded from the analysis. We discuss this further in Section 8.2. On iOS, only 65 apps failed to launch and 18 apps could not be installed because they require a newer version of iOS than we can use. The remaining failures on both platforms were mostly due to Appium or Frida commands failing even after multiple retries.

In the interest of reproducibility, the processed data behind all graphs is available in our GitHub repository.

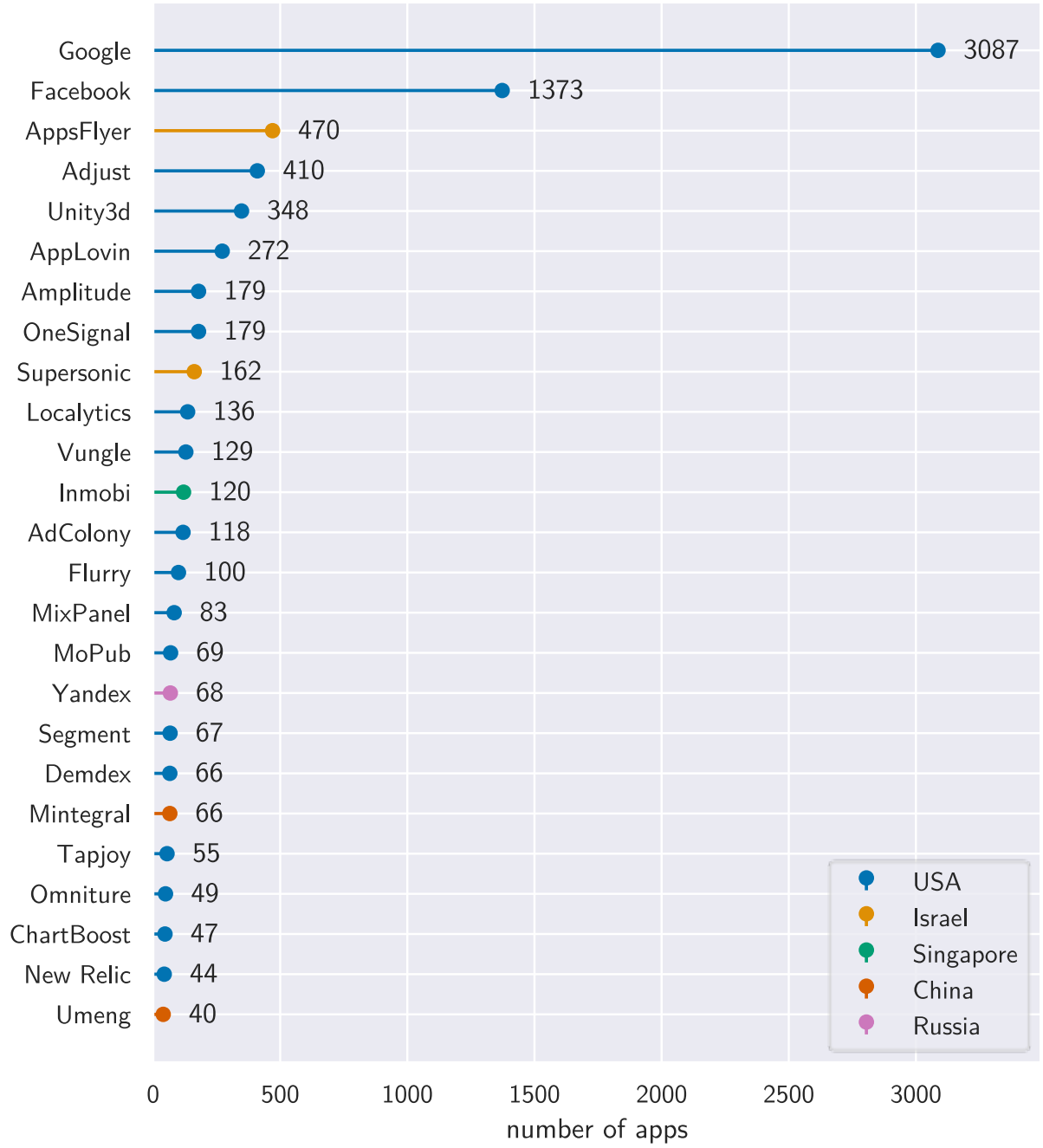
7.1. Network Traffic and Tracking

https://benjamin-altpeter.de/doc/thesis-consent-dialogs.pdf

78 % of apps contacted at least one tracker even without any interaction.

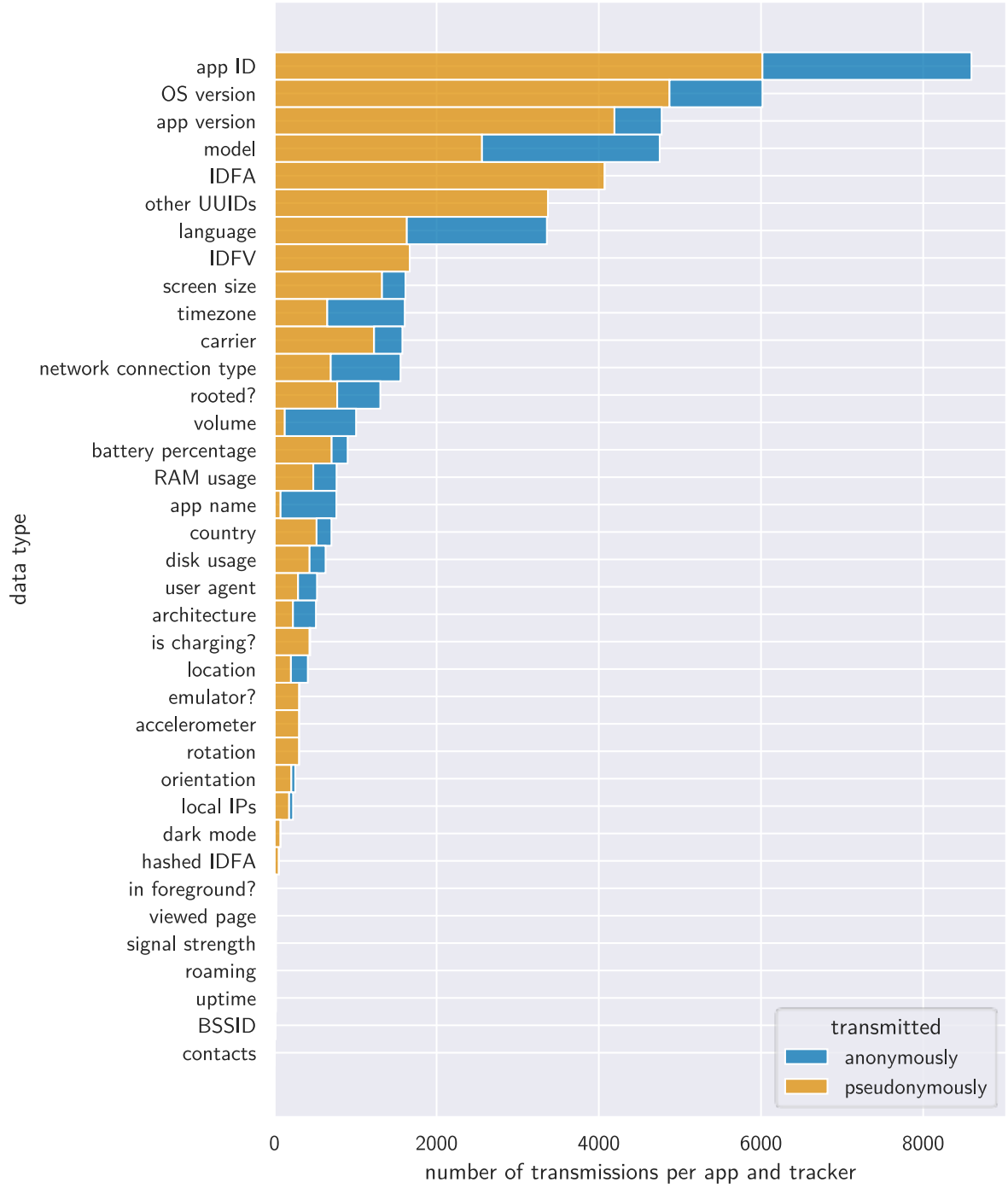


Number of apps (out of 4,388) that sent requests to the 25 most common trackers in our dataset according to Exodus within one minute of starting them and without user interaction.

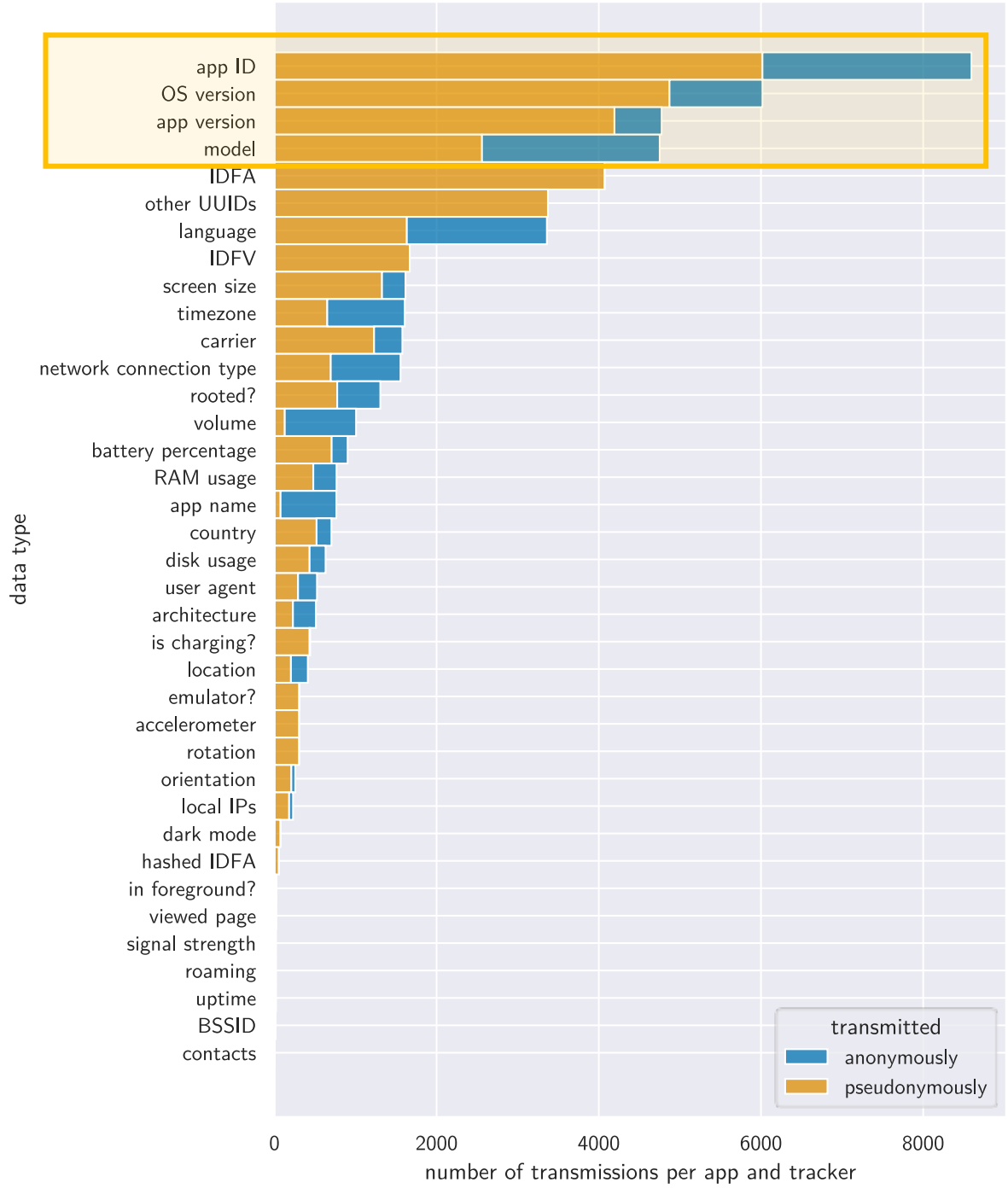


Number of apps (out of 4,388) that sent requests to the 25 most common trackers in our dataset according to Exodus within one minute of starting them and without user interaction, coloured according to the country of their main establishment.

33.3 % of **all requests**
(without interaction)
went to tracking servers.



Number of times the observed data types were transmitted per app and tracker before interaction. Note that we are also using the term “IDFA” for the Google Advertising ID here.



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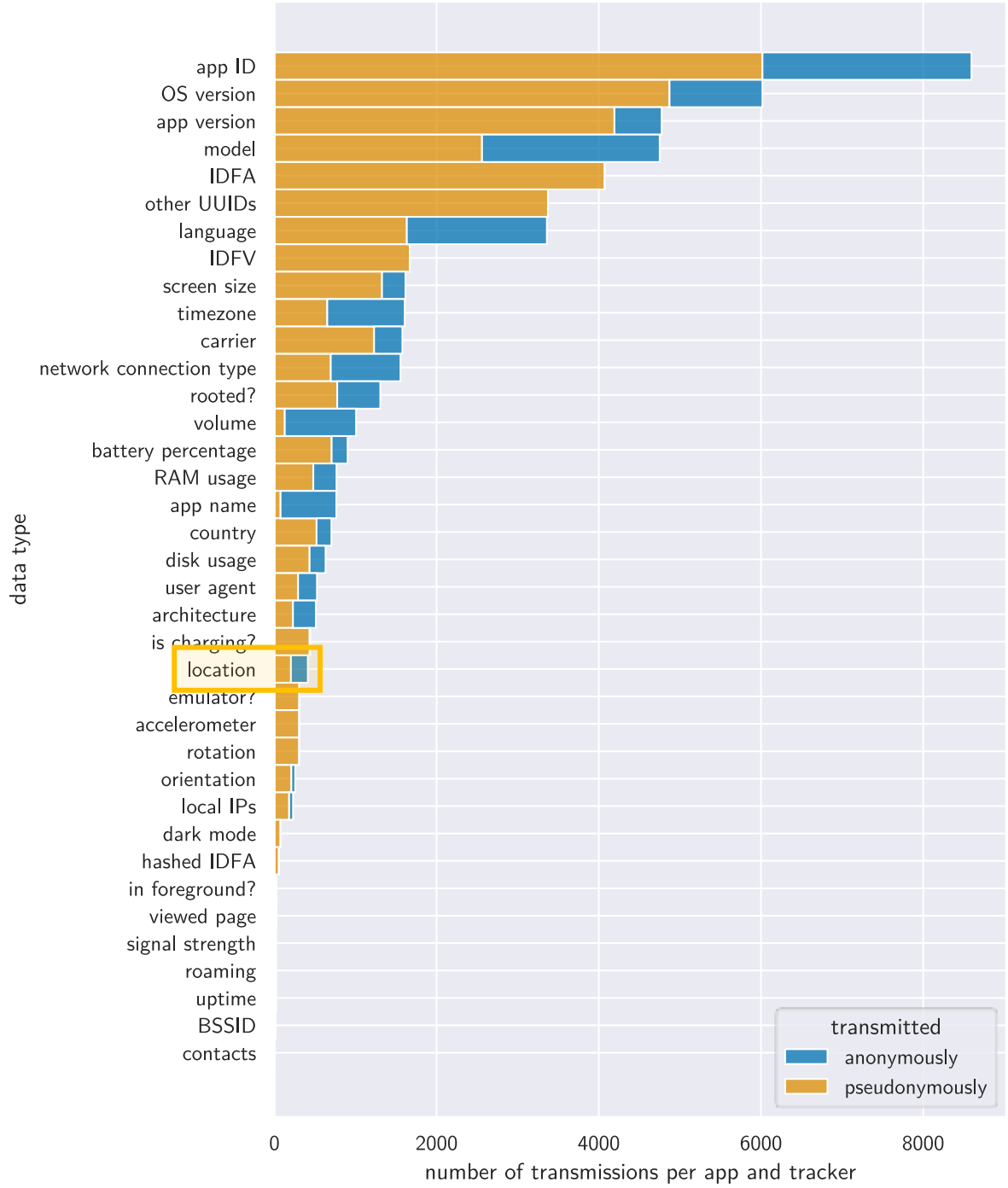

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Consent dialogs

How do apps (try to get) the user's consent and how prevalent are dark patterns?

Consent elements

- We distinguish between:
  - **link**: App only links to a privacy policy, e.g. in a menu or footer.
  - **notice**: App informs of the processing but doesn't give a choice.
  - **dialog**: App informs of the processing and actively solicits consent.

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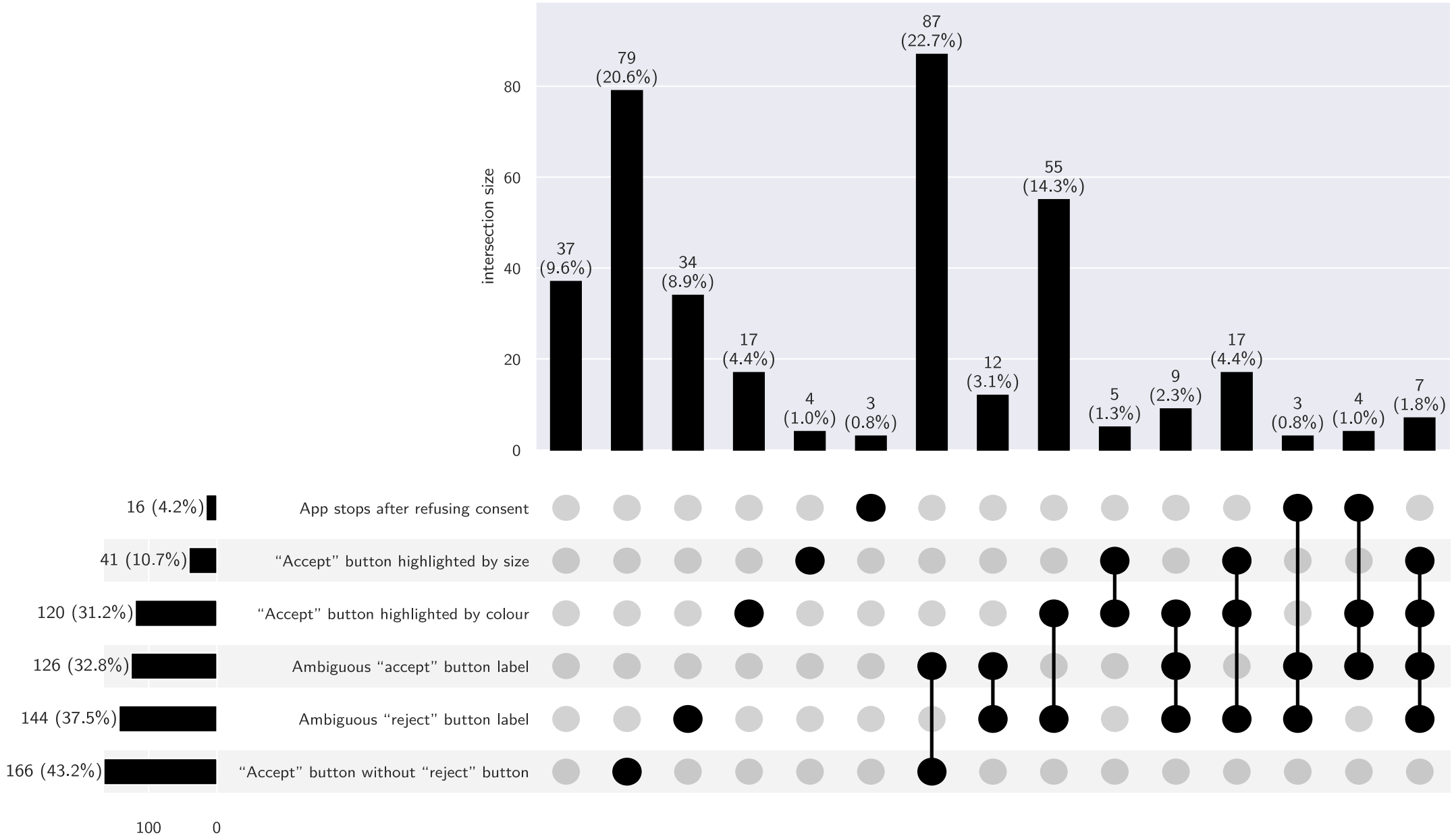
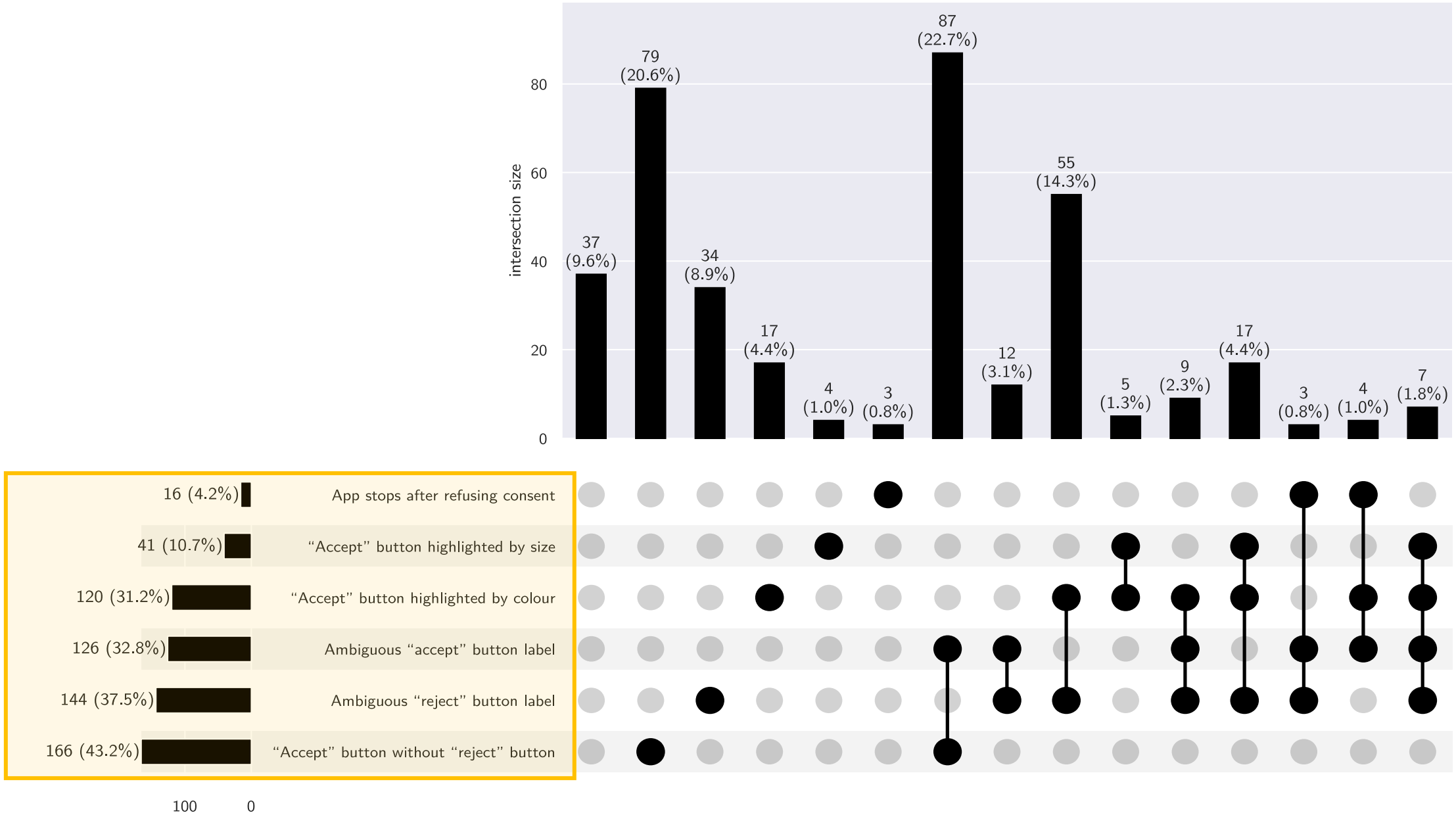
Classification	Detections on Android	Detections on iOS	Detections in total
dialog	149 (7.21 %)	235 (10.13 %)	384 (8.75 %)
notice	108 (5.22 %)	87 (3.75 %)	195 (4.44 %)
link	103 (4.98 %)	103 (4.44 %)	206 (4.69 %)
neither	1,708 (82.59 %)	1,895 (81.68 %)	3,603 (82.11 %)



UpSet plot of the different combinations of dark patterns we have detected in consent dialogs. **Subsets with less than three elements are omitted.** Also note that not all combinations are possible.



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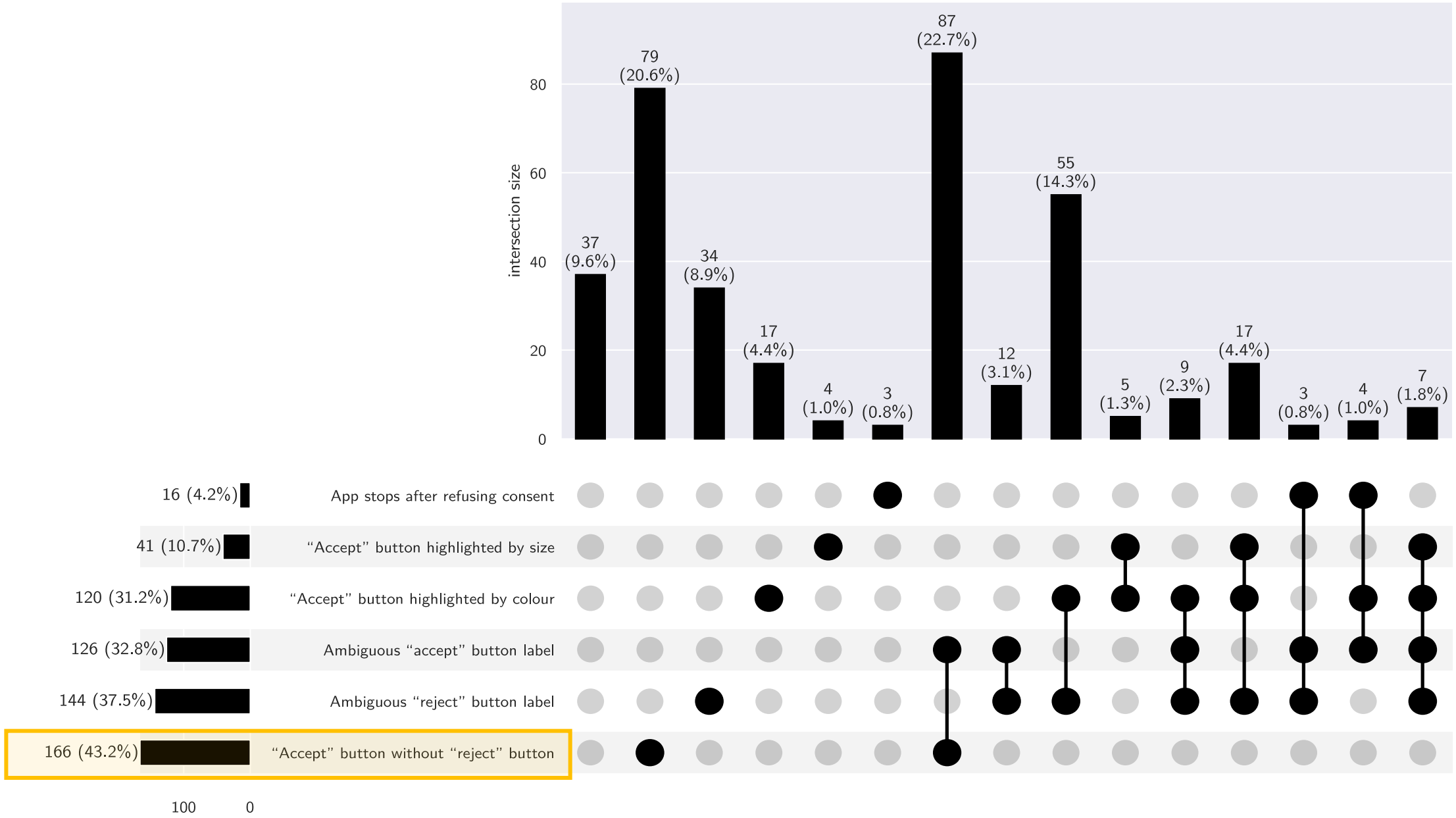

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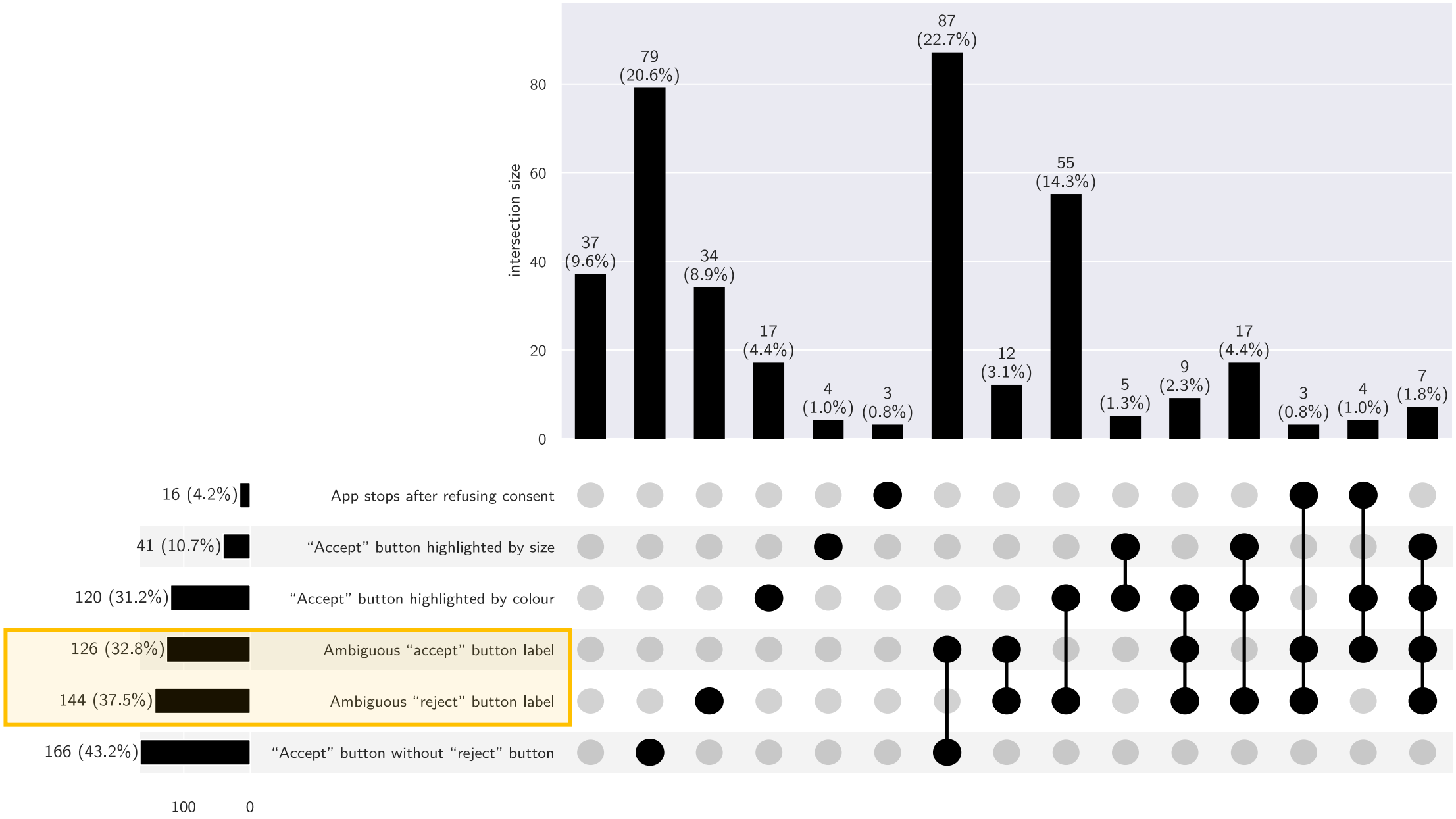

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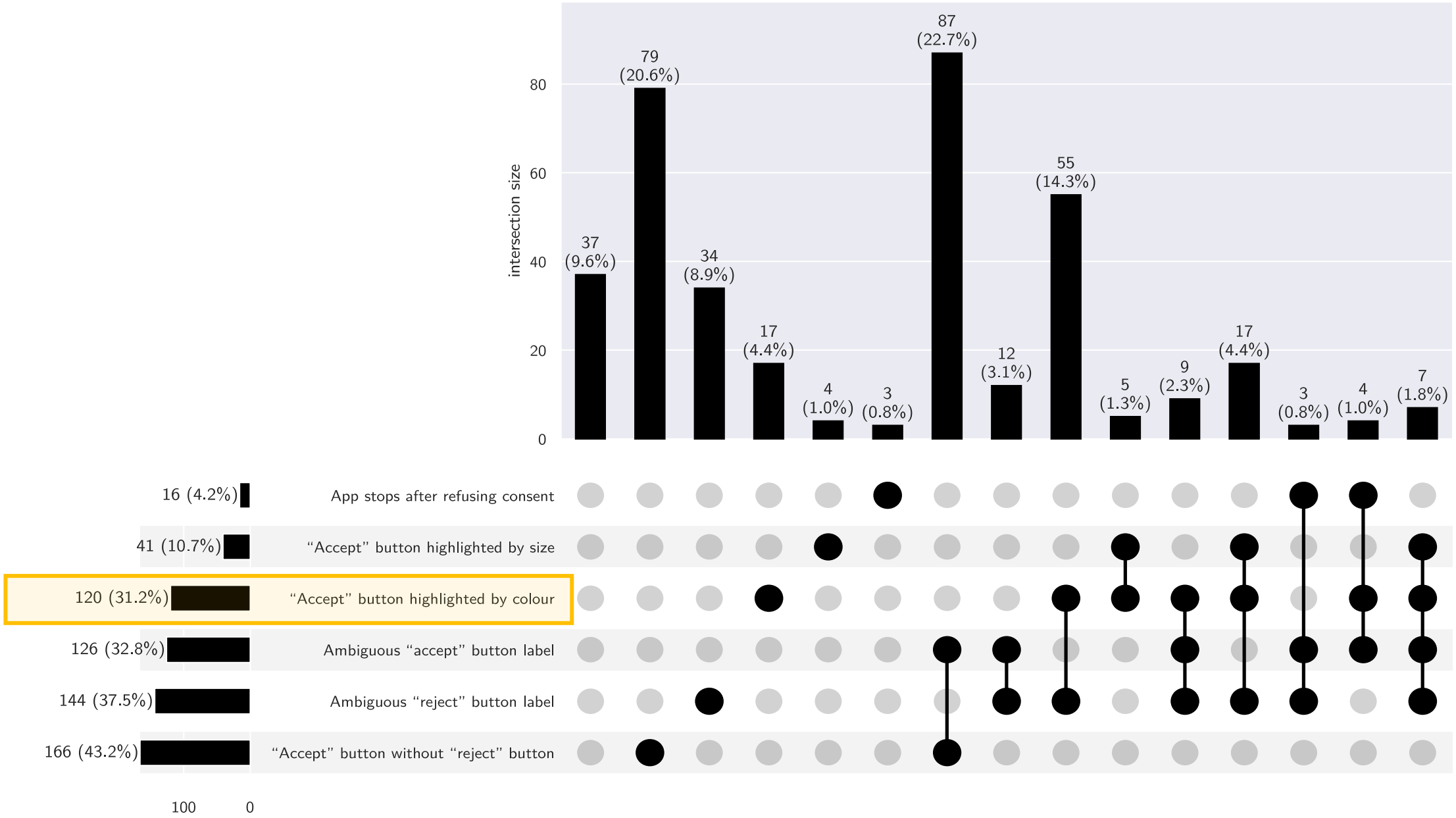

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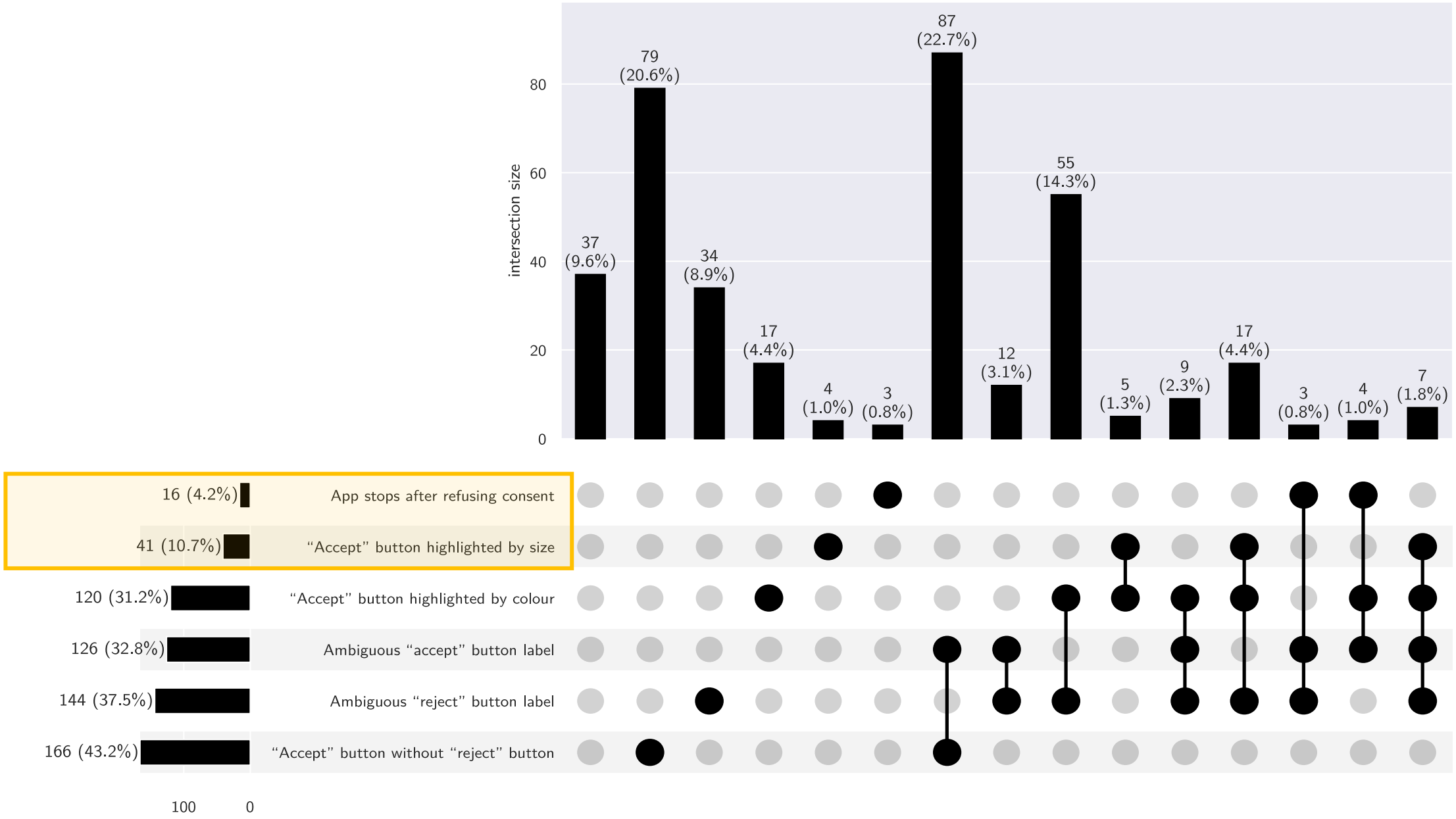

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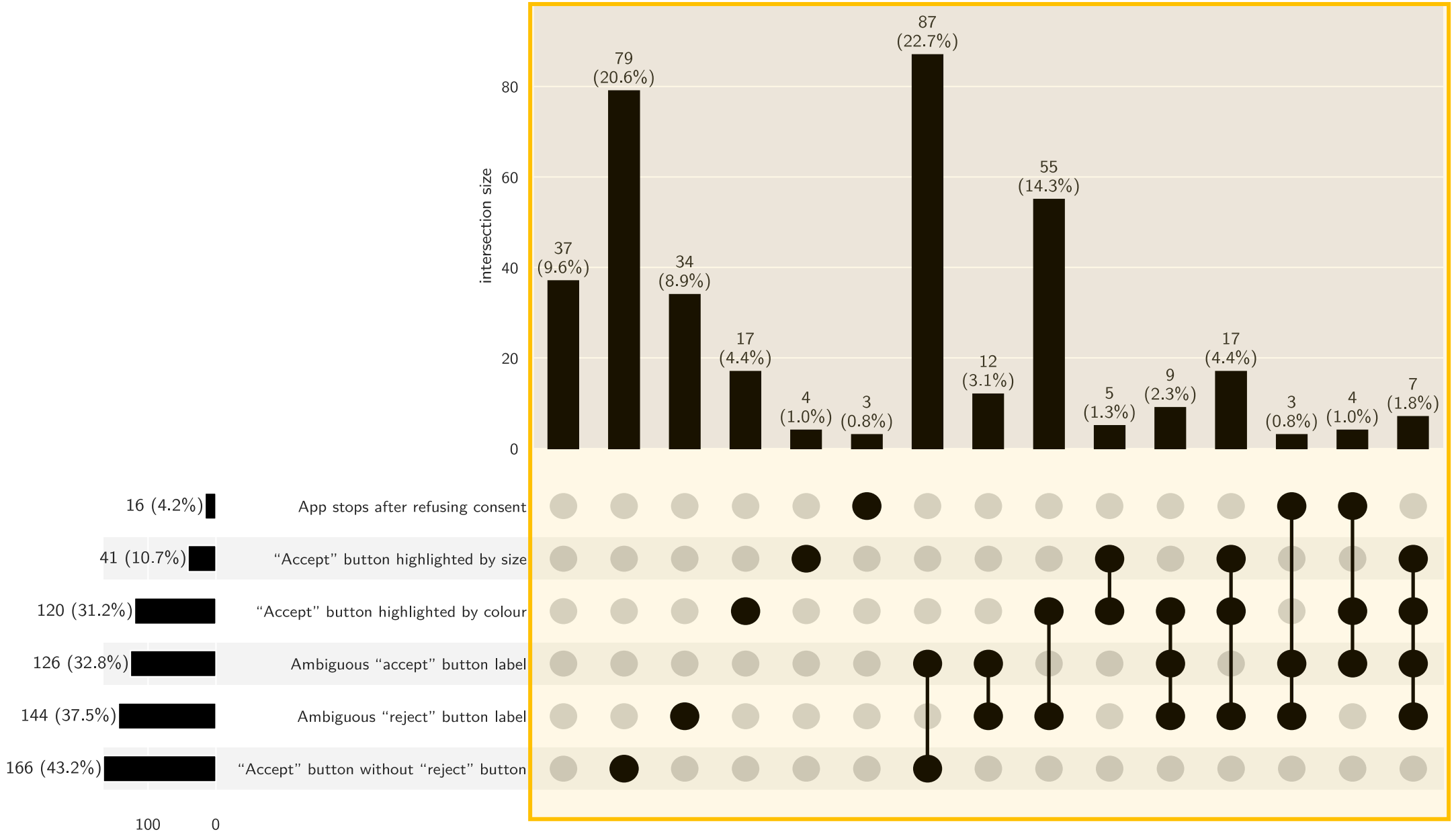

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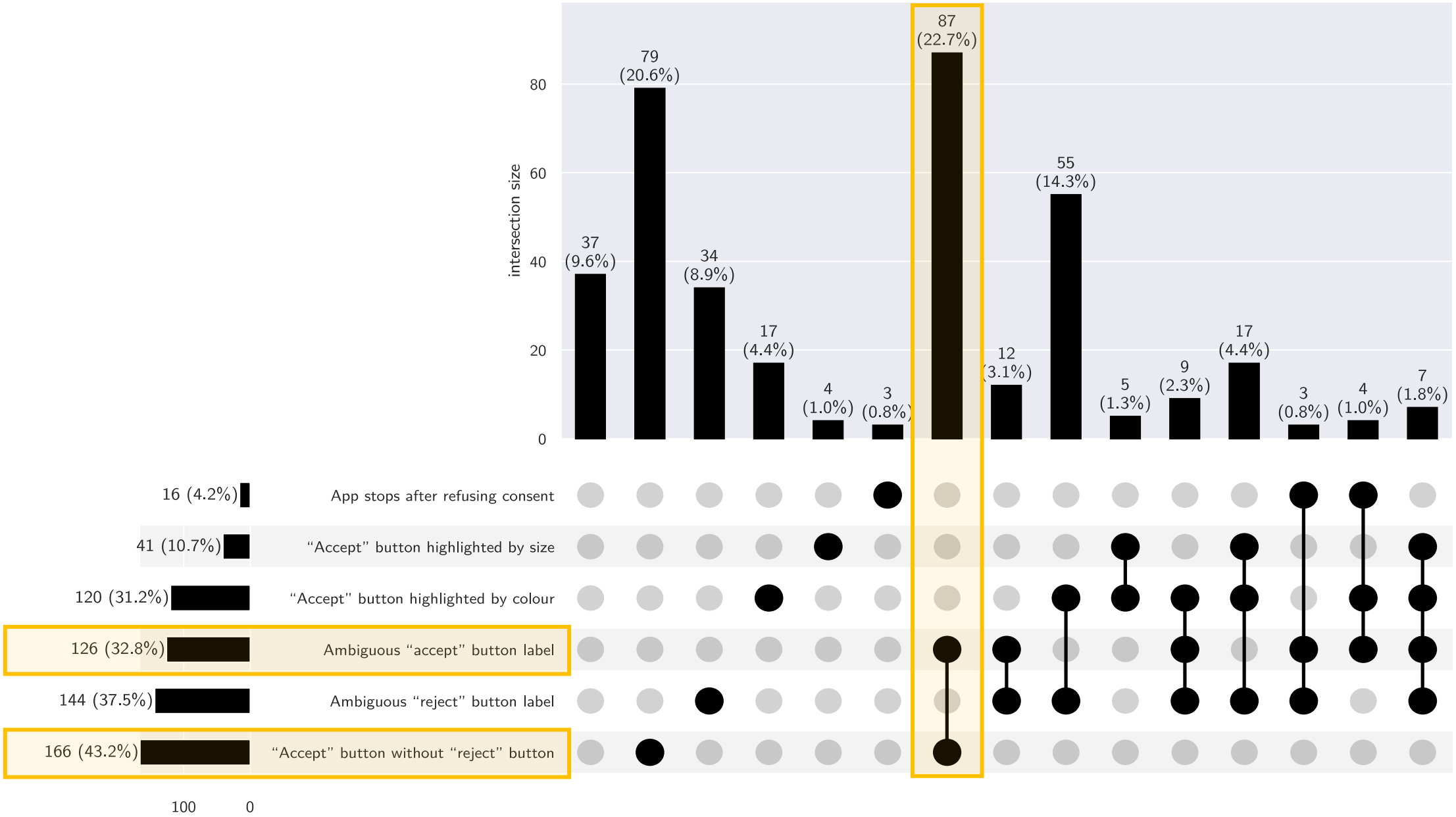

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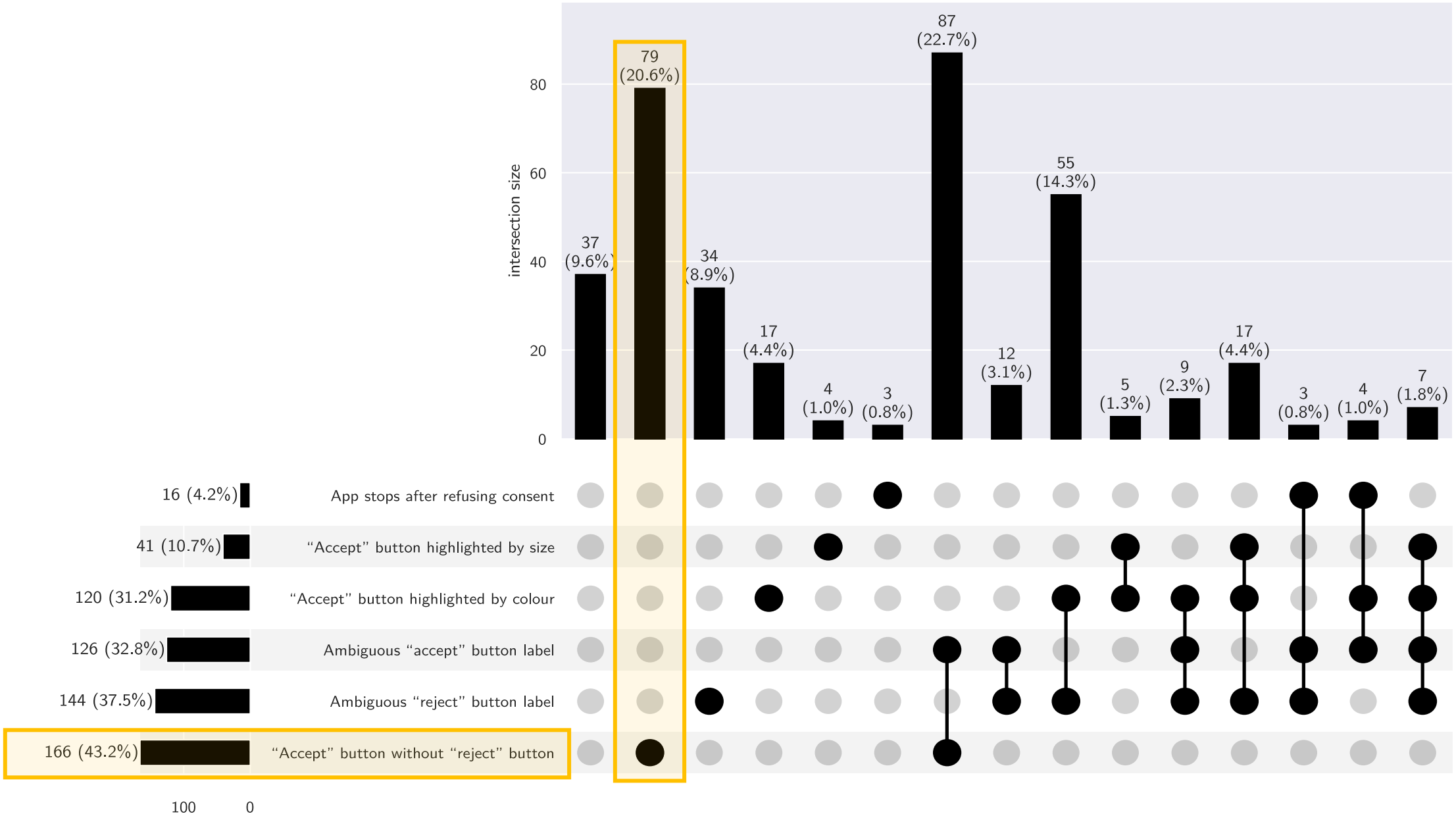

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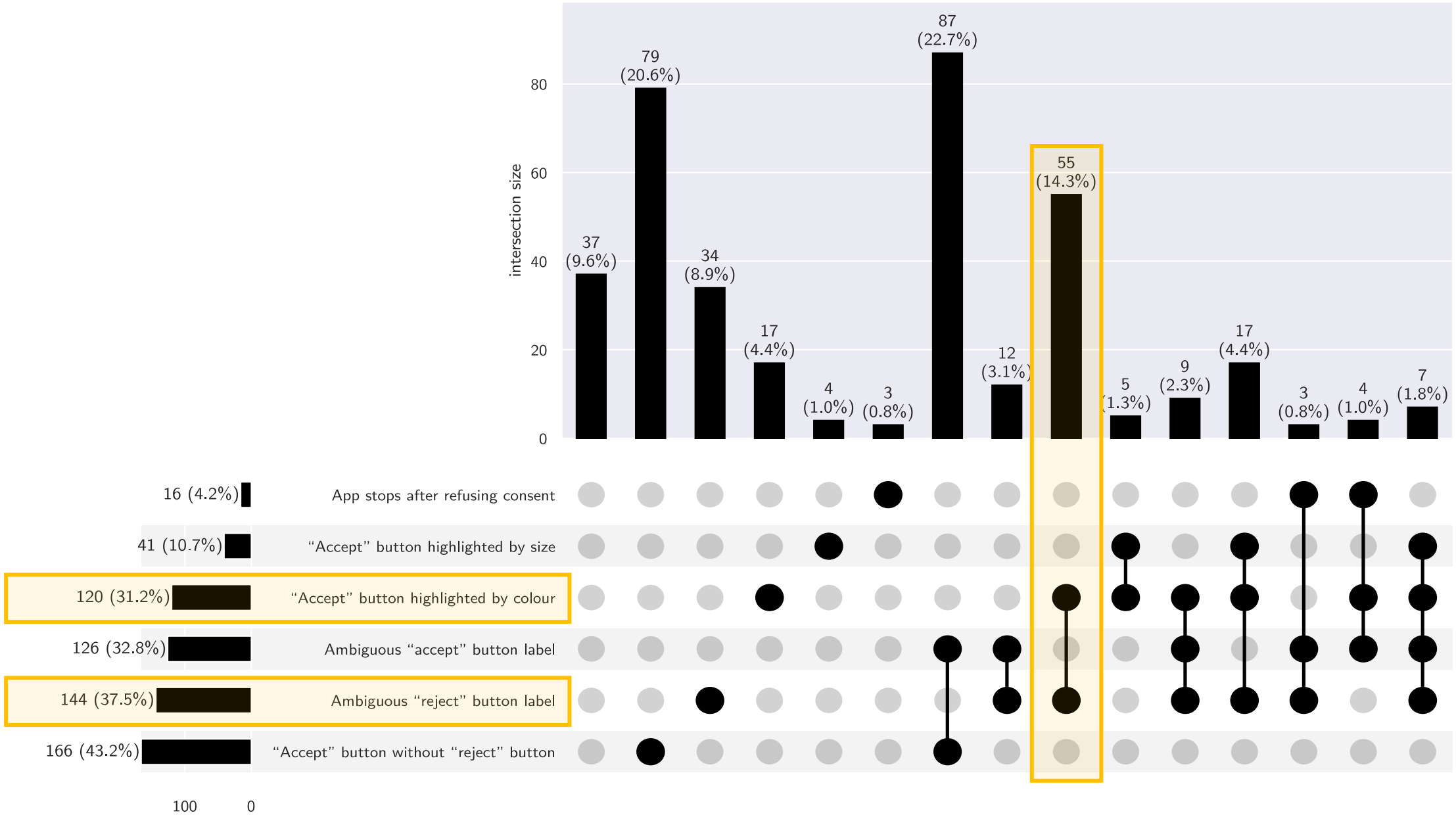

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> 90 % of consent dialogs exhibited at least one dark pattern.

Methods and tools

Photo adapted after: “assorted-type hand tool lot” by Ashim D’Silva (Unsplash license)

Device instrumentation

Based on lots of reverse engineering, we have developed methods to fully automate Android and iOS instrumentation and traffic collection.

Android instrumentation

- Target: Android emulator or phone (rooted)
  (we test on Android 11 and 13)

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  - Certificate pinning bypass: objection & Frida

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  - Certificate pinning bypass: SSL Kill Switch 2

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README.md

cyanoacrylate

> Toolkit for large-scale automated traffic analysis of mobile apps on Android and iOS.

This toolkit was designed to run traffic analyses on lots of apps without much user interaction, especially to analyze the tracking behavior of mobile apps. It supports running apps on Android and iOS, currently on physical devices as well as an emulator for Android. It uses mitmproxy to capture the device traffic and appstraction to instrument the devices.

The current features include:

- Checking if device traffic is altered by a DNS blocker
- Starting and managing an Android emulator
- Collecting HTTP(S) traffic in HAR format
- Automatic CA management and WireGuard mitmproxy setup

Installation

You can install cyanoacrylate using yarn or npm:

```
yarn add cyanoacrylate
# or `npm i cyanoacrylate`
```

https://github.com/tweaselORG/cyanoacrylate

```
import { startAnalysis } from 'cyanoacrylate';

(async () => {
    const analysis = await startAnalysis({
        platform: 'android', runTarget: 'device', targetOptions: {},
        capabilities: ['frida', 'certificate-pinning-bypass'],
    });
    await analysis.ensureDevice();

    const appAnalysis = await analysis.startAppAnalysis([
        '/tmp/apps/duolingo/com.duolingo.apk',
        '/tmp/apps/duolingo/config.x86.1350.com.duolingo.apk',
        '/tmp/apps/duolingo/config.xxhdpi.1350.com.duolingo.apk',
    ]);
    await appAnalysis.installApp();
    await appAnalysis.setAppPermissions();
    await appAnalysis.startTrafficCollection();
    await appAnalysis.startApp();

    await pause(60_000);

    await appAnalysis.stopTrafficCollection();
    const results = await appAnalysis.stop();
    await analysis.stop();
})();
```

```
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        '/tmp/apps/duolingo/config.xxhdpi.1350.com.duolingo.apk',
    ]);
    await appAnalysis.installApp();
    await appAnalysis.setAppPermissions();
    await appAnalysis.startTrafficCollection();
    await appAnalysis.startApp();

    await pause(60_000);

    await appAnalysis.stopTrafficCollection();
    const results = await appAnalysis.stop();
    await analysis.stop();
})();
```

```
import { startAnalysis } from 'cyanoacrylate';

(async () => {
    const analysis = await startAnalysis({
        platform: 'android', runTarget: 'device', targetOptions: {},
        capabilities: ['frida', 'certificate-pinning-bypass'],
    });
    await analysis.ensureDevice();

    const appAnalysis = await analysis.startAppAnalysis([
        '/tmp/apps/duolingo/com.duolingo.apk',
        '/tmp/apps/duolingo/config.x86.1350.com.duolingo.apk',
        '/tmp/apps/duolingo/config.xxhdpi.1350.com.duolingo.apk',
    ]);
    await appAnalysis.installApp();
    await appAnalysis.setAppPermissions();
    await appAnalysis.startTrafficCollection();
    await appAnalysis.startApp();

    await pause(60_000);

    await appAnalysis.stopTrafficCollection();
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        '/tmp/apps/duolingo/config.x86.1350.com.duolingo.apk',
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    await appAnalysis.startTrafficCollection();
    await appAnalysis.startApp();

    await pause(60_000);

    await appAnalysis.stopTrafficCollection();
    const results = await appAnalysis.stop();
    await analysis.stop();
})();
```
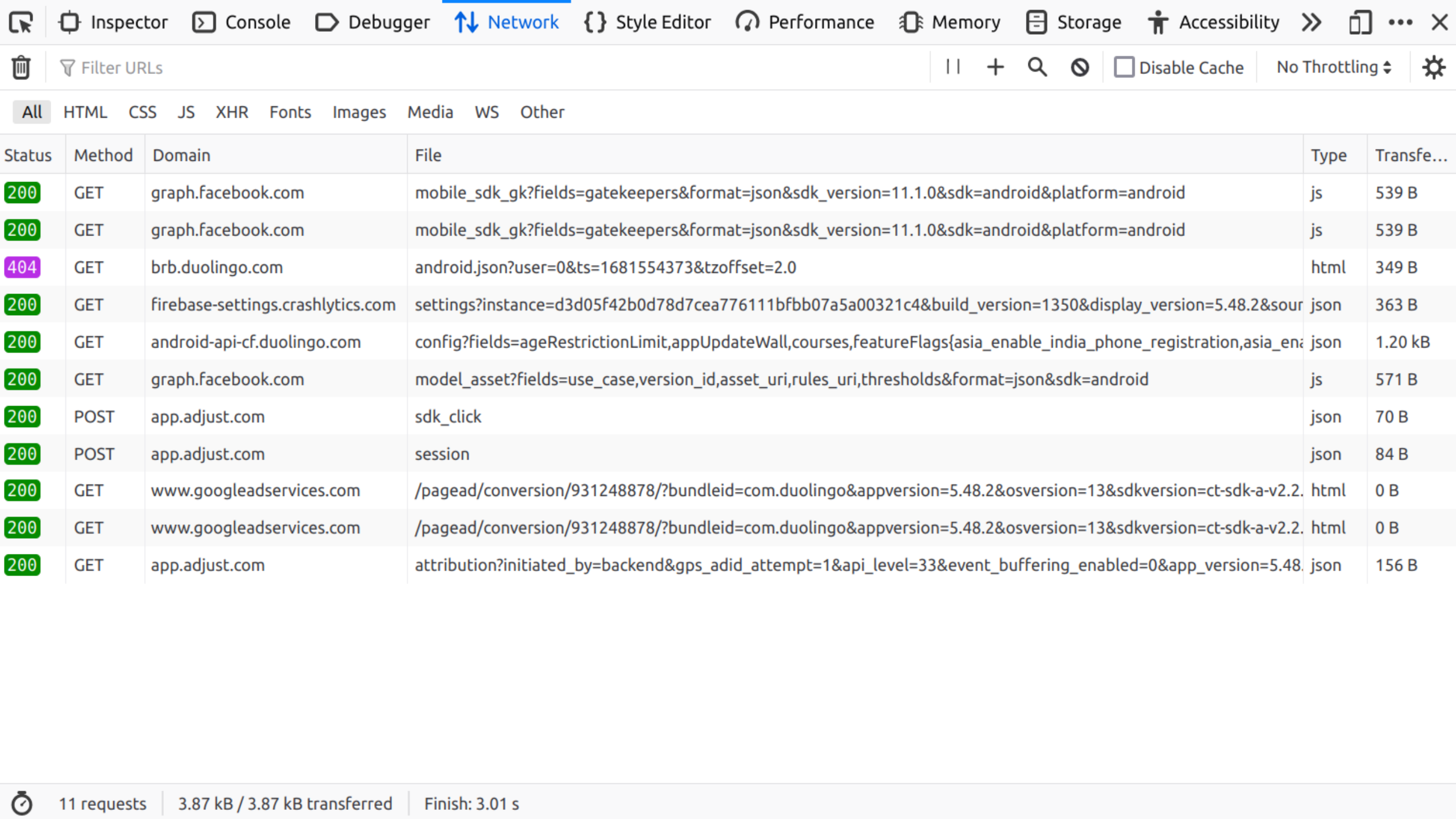



Status	Method	Domain	File	Type	Transfe...
200	GET	graph.facebook.com	mobile_sdk_gk?fields=gatekeepers&format=json&sdk_version=11.1.0&sdk=android&platform=android	js	539 B
200	GET	graph.facebook.com	mobile_sdk_gk?fields=gatekeepers&format=json&sdk_version=11.1.0&sdk=android&platform=android	js	539 B
404	GET	brb.duolingo.com	android.json?user=0&ts=1681554373&tzoffset=2.0	html	349 B
200	GET	firebase-settings.crashlytics.com	settings?instance=d3d05f42b0d78d7cea776111bfbb07a5a00321c4&build_version=1350&display_version=5.48.2&sour	json	363 B
200	GET	android-api-cf.duolingo.com	config?fields=ageRestrictionLimit,appUpdateWall,courses,featureFlags{asia_enable_india_phone_registration,asia_ena	json	1.20 kB
200	GET	graph.facebook.com	model_asset?fields=use_case,version_id,asset_uri,rules_uri,thresholds&format=json&sdk=android	js	571 B
200	POST	app.adjust.com	sdk_click	json	70 B
200	POST	app.adjust.com	session	json	84 B
200	GET	www.googleadservices.com	/pagead/conversion/931248878/?bundleid=com.duolingo&appversion=5.48.2&osversion=13&sdkversion=ct-sdk-a-v2.2.	html	0 B
200	GET	www.googleadservices.com	/pagead/conversion/931248878/?bundleid=com.duolingo&appversion=5.48.2&osversion=13&sdkversion=ct-sdk-a-v2.2.	html	0 B
200	GET	app.adjust.com	attribution?initiated_by=backend&gps_adid_attempt=1&api_level=33&event_buffering_enabled=0&app_version=5.48.	json	156 B

README.md

appstraction

> An abstraction layer for common instrumentation functions (e.g. installing and starting apps, setting preferences, etc.) on Android and iOS.

Appstraction provides an abstraction layer for common instrumentation functions on mobile platforms, specifically Android and iOS. This includes installing, uninstalling, and starting apps, managing their permissions, but also managing devices, like resetting to snapshots, setting the clipboard content, configuring the proxy, etc. Appstraction is built primarily for use in mobile privacy research, but can be used for other purposes as well.

Features

With appstraction, you can perform the following actions programmatically on Android and iOS (for a full list with additional details, see the API reference for the `PlatformApi` type):

- Reset an emulator to a snapshot.
- Install and uninstall apps (including split APKs on Android).
- Check whether an app is installed.
- Set an app's permissions, either granting everything or granularly specifying which permissions to grant or deny.
- Configure an app's battery optimization settings.
- Start and stop apps.

https://github.com/tweaselORG/appstraction

README.md

Tweasel CLI

> Command-line tool for the libraries of the tweasel project.

The tweasel project provides various JavaScript libraries for instrumenting and analyzing mobile apps and their traffic. `tweasel-cli` is a command-line tool that provides a convenient wrapper around these libraries for common use cases, so you don't have to write any code. Currently, support for `cyanoacrylate` and `TrackHAR` is implemented.

The tweasel CLI provides the following commands:

- `record-traffic`: Record the traffic of an Android or iOS app in HAR format.

  The app will be installed and started automatically on the device or emulator. Its traffic will be then recorded for the specified duration and saved as a HAR file at the end. You can either record the traffic of the entire system or only the specified app (default).

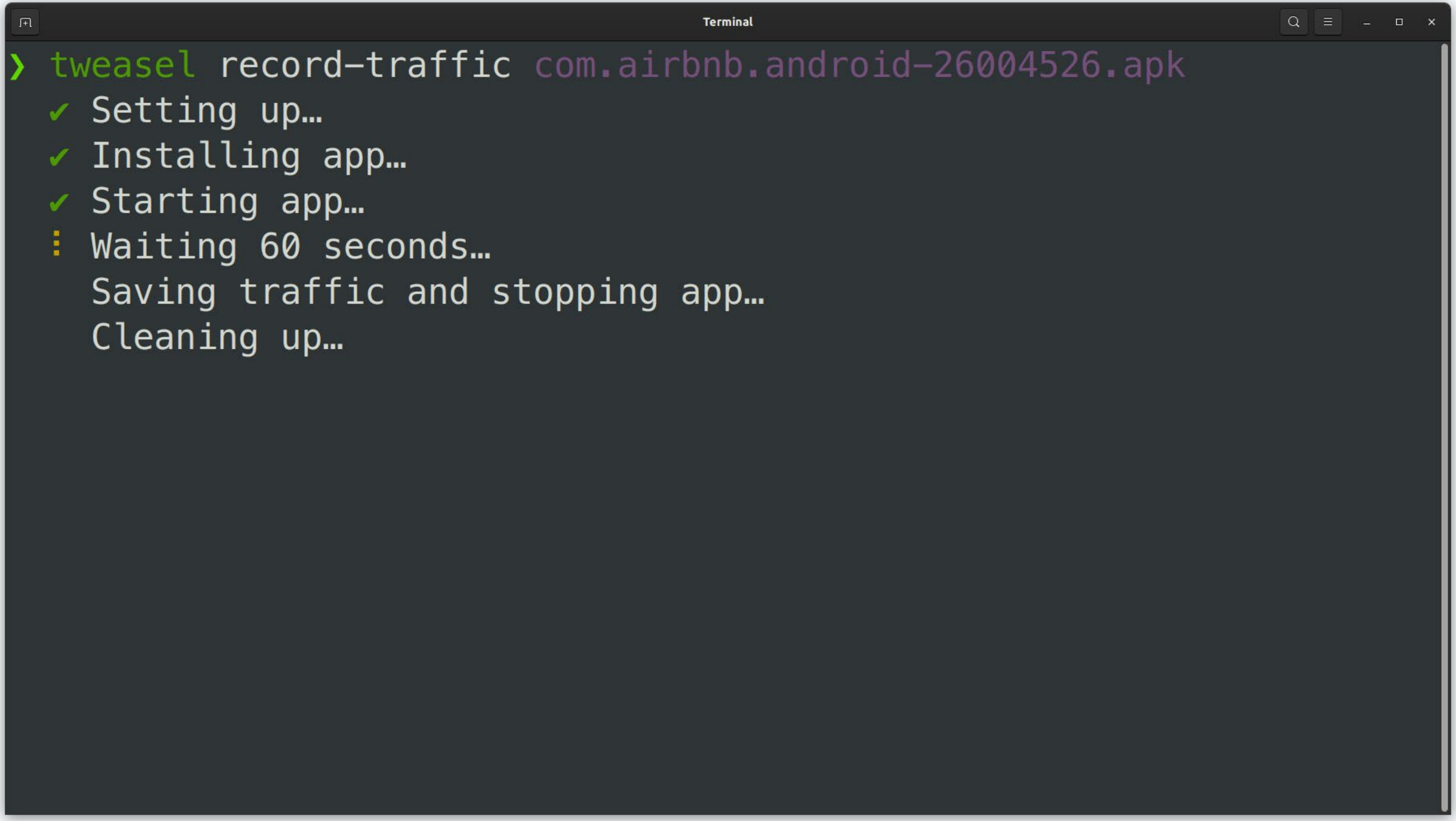
  The app can optionally be uninstalled automatically afterwards.

- `detect-tracking`: Detect tracking data transmissions from traffic in HAR format.

  The traffic in the specified HAR file will be analyzed using TrackHAR. The detected tracking data can be output as a human-readable table or as JSON.

More commands and support for the other libraries will be added soon.

https://github.com/tweaselORG/cli


Terminal
❯ tweasel record-traffic com.airbnb.android-26004526.apk
✔ Setting up…
✔ Installing app…
✔ Starting app…
⋮ Waiting 60 seconds…
Saving traffic and stopping app…
Cleaning up…

Downloading apps

Google and Apple don’t support our use case, so we have to turn to third-party tools and, once again, reverse engineering.

Downloading Android apps

- There are many tools to download APKs.
- But they tend to break often.

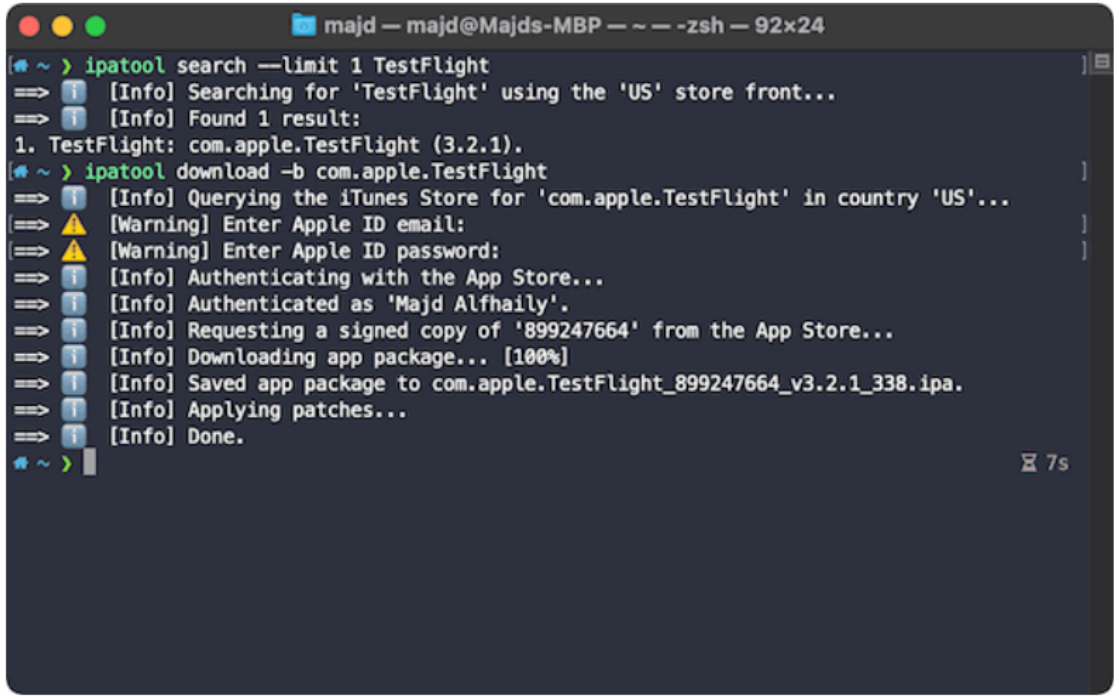
- We have used these:
  - matlink/gplaycli
  - ClaudiuGeorgiu/PlaystoreDownloader
  - EFForg/apkeep
  - 89z/googleplay (permalink: https://2a.pages.dev/googleplay)

README.md

IPATool

Release v2.0.0 | License MIT | Unit Tests passing | Integration Tests failing | Swift 5.5 | macOS 10.15+

`ipatool` is a command line tool that allows you to search for iOS apps on the App Store and download a copy of the app package, known as an *ipa* file.



- Requirements
- Installation
  - Manual

https://github.com/majd/ipatool

Fixes #28: Add support for buying new apps #51

New issue

Merged **majd** merged 1 commit into `majd:main` from `baltpeter:b_buy-apps` on Mar 21

Conversation 1 | Commits 1 | Checks 6 | Files changed 7 | +239 −13

baltpeter commented on Mar 20 • edited ▾ Contributor •••

Thank you very much for building and open-sourcing ipatool! I'm doing research on data protection in Android and iOS apps, so this is very helpful.

Previously, I was (ab)using 3uTools for downloading IPAs but having to do that manually through a GUI was of course very cumbersome for the thousands of apps I need.

This PR adds support for downloading apps the used Apple ID doesn't already own (and thus fixes #28), a feature I need.

This is based on quite a lot of trial and error, and fighting with Apple's servers. I've looked at the network traffic of every program that can download IPAs that I could find. As you said, Apple Configurator 2 doesn't have the capability to buy new apps (same for tools based on that API, like iMazing). But older versions of iTunes could also download and buy apps (3u's mechanism is based on that, and I've also observed the same requests from the iOS App Store a year ago, though they seem to have changed that since...) through this endpoint:

```
https://buy.itunes.apple.com/WebObjects/MZBuy.woa/wa/buyProduct
```

Surprisingly, this endpoint also works with a Configurator user agent and corresponding auth cookies, though it behaves a little differently for that (for iTunes, it returns essentially the same information as the `volumeStoreDownloadProduct` endpoint, but for Configurator, it doesn't include the download URL in the response). Luckily, it seems like many of the parameters iTunes sets (including the dreaded `kbsync`) aren't actually necessary and can just be left out from the request.

I've tested this on two different Apple IDs, so hopefully it should work universally.

🎉 3 🚀 2

Fixes majd#28: Add support for buying new apps ••• 3fe990a

https://github.com/majd/ipatool/pull/51

README.md

parse-play

> Library for fetching and parsing select data on Android apps from the Google Play Store via undocumented internal APIs.

This library is able to fetch and parse data from undocumented internal API endpoints of the Google Play Store. Currently, it can fetch the charts of the most popular apps, according to various criteria, and apps' data safety labels.
I'll extend the supported API endpoints over time, as per what I need for my projects. The focus will likely be on functions useful for research into mobile privacy and data protection.

As all the used endpoints are undocumented, I had to resort to reverse-engineering the Play Store website, which involved some amount of guessing as to which values mean what. It is possible that I have misinterpreted some of them. It is also entirely possible that some or all of the endpoints will stop working out of the blue at some point, or change their request and/or response formats.

Installation

You can install parse-play using yarn or npm:

```
yarn add parse-play
# or `npm i parse-play`
```

API reference

https://github.com/baltpeter/parse-play

```
import { fetchTopCharts } from 'parse-play';

(async () => {
    const topChart = await fetchTopCharts(
        {
            category: 'APPLICATION',
            chart: 'topselling_free',
            count: 100
        },
        { country: 'FR', language: 'EN' }
    );

    console.log(topChart?.length);
    // 100

    console.log(topChart?.[0]?.app_id, '::', topChart?.[0]?.name);
    // com.whatsapp :: WhatsApp Messenger
})();
```

```
import { fetchTopCharts } from 'parse-play';

(async () => {
    const topChart = await fetchTopCharts(
        {
            category: 'APPLICATION',
            chart: 'topselling_free',
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        },
        { country: 'FR', language: 'EN' }
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})();
```

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import { fetchTopCharts } from 'parse-play';

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            count: 100
        },
        { country: 'FR', language: 'EN' }
    );

    console.log(topChart?.length);
    // 100

    console.log(topChart?.[0]?.app_id, '::', topChart?.[0]?.name);
    // com.whatsapp :: WhatsApp Messenger
})();
```

```
import { fetchDataSafetyLabels } from 'parse-play';

(async () => {
    const labels = await fetchDataSafetyLabels(
        [{ app_id: 'com.zhiliaoapp.musically' }],
        { language: 'EN' }
    );

    console.dir(labels, { depth: null });
})();
```

```
{
  name: 'TikTok: Videos, Lives & Musik',
  app_id: 'com.zhiliaoapp.musically',
  developer: {
    name: 'TikTok Pte. Ltd.',
    path: '/store/apps/developer?id=TikTok+Pte.+Ltd.',
    website_url: 'https://www.tiktok.com/',
    email: 'feedback@tiktok.com',
    address: '1 Raffles Quay, #26-10,\nSouth Tower,\nSingapore\n048583'
  },
  icon_url: 'https://play-lh.googleusercontent.com/dl42FLLV8o9mP-NOubtR-2rDzQkc4mqx6[…]',
  privacy_policy_url: 'https://www.tiktok.com/legal/privacy-policy',
  data_shared: [],
  data_collected: [
    {
      category: 'Location',
      type: 'Approximate location',
      purposes: [
        'App functionality',
        'Analytics',
        'Advertising or marketing',
        'Personalization'
      ],
      optional: true
    },
```

```
{
  name: 'TikTok: Videos, Lives & Musik',
  app_id: 'com.zhiliaoapp.musically',
  developer: {
    name: 'TikTok Pte. Ltd.',
    path: '/store/apps/developer?id=TikTok+Pte.+Ltd.',
    website_url: 'https://www.tiktok.com/',
    email: 'feedback@tiktok.com',
    address: '1 Raffles Quay, #26-10,\nSouth Tower,\nSingapore\n048583'
  },
  icon_url: 'https://play-lh.googleusercontent.com/dl42FLLV8o9mP-NOubtR-2rDzQkc4mqx6[…]',
  privacy_policy_url: 'https://www.tiktok.com/legal/privacy-policy',
  data_shared: [],
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    {
      category: 'Location',
      type: 'Approximate location',
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        'Analytics',
        'Advertising or marketing',
        'Personalization'
      ],
      optional: true
    },
```

```
{
  name: 'TikTok: Videos, Lives & Musik',
  app_id: 'com.zhiliaoapp.musically',
  developer: {
    name: 'TikTok Pte. Ltd.',
    path: '/store/apps/developer?id=TikTok+Pte.+Ltd.',
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        'App functionality',
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        'Advertising or marketing',
        'Personalization'
      ],
      optional: true
    },
```

README.md

parse-tunes

> Library for fetching select data on iOS apps from the Apple Apple Store via undocumented internal iTunes APIs.

This library is able to fetch and parse data from undocumented internal API endpoints of the Apple App Store. Currently, it can fetch the charts of the most popular apps, according to various criteria, and details (including privacy labels) for individual apps. We'll extend the supported API endpoints in the future. The focus will mostly be on functions useful for research into mobile privacy and data protection.

As all the used endpoints are undocumented, we had to resort to reverse-engineering them. It is possible that we have misinterpreted the meaning of parameters or endpoints. It is also entirely possible that some or all of the endpoints will stop working out of the blue at some point, or change their request and/or response formats.

Installation

You can install parse-tunes using yarn or npm:

```
yarn add parse-tunes
# or `npm i parse-tunes`
```

API reference

https://github.com/tweaselORG/parse-tunes

Detecting tracking data transmissions

How can we tell what (personal) data is included in a request to a tracking server in an automated manner?

Audible on Android

POST https://control.kochava.com/track/json


```
"action": "install",
"kochava_device_id": "KA3731610548931t77133e5ade9f4[…]",
"sdk_protocol": "14",
"sdk_version": "AndroidTracker 3.7.3",
"nt_id": "d45c5-1-47dfae35-b398-40d2-a2e6-bd7bb40c88d0",
"data": {
  "screen_brightness": 0.4,
  "device_orientation": "portrait",
  "volume": 0.3333,
  "carrier_name": "Android",
  "adid": "827d8162-0e1c-48cd-892e-4abd3df95ba8",
  "device": "sdk_gphone_x86_64_arm64-google",
  "disp_h": 2560,
  "disp_w": 1440,
  "package": "com.audible.application",
  "installed_date": 1610548859,
  "os_version": "Android 11",
  "device_limit_tracking": false,
  "is_genuine": false,
  "screen_dpi": 560,
  "screen_inches": 5,
  "manufacturer": "Google",
  "product_name": "sdk_gphone_x86_64_arm64",
  "architecture": "x86_64",
  "battery_status": "not_charging",
  "battery_level": 77,
  "device_cores": 2,
  "locale": "en-US",
  "timezone": "Europe/Berlin",
  "bluetooth_name": "sdk_gphone_x86_64_arm64",
  "ui_mode": "Normal",
  "notifications_enabled": true,
  "background_location": false,
  "bms": 1610548366742,
  "network_conn_type": "wifi",
  "network_metered": false,
  "usertime": 1610548931,
  "uptime": 6.764,
  "state_active": true,
  "app_limit_tracking": false,
  "identity_link": {
    "marketingcloudvisitorid":
      "14340173368323804205870968500570471451"
  }
},
"sdk_id": "c456-s26905-",
"send_date": "2021-01-13T14:42:17.885Z"
```

Audible on Android

POST https://control.kochava.com/track/json


```
"action": "install",
"kochava_device_id": "KA3731610548931t77133e5ade9f4[…]",
"sdk_protocol": "14",
"sdk_version": "AndroidTracker 3.7.3",
"nt_id": "d45c5-1-47dfae35-b398-40d2-a2e6-bd7bb40c88d0",
"data": {
  "screen_brightness": 0.4,
  "device_orientation": "portrait",
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  "carrier_name": "Android",
  "adid": "827d8162-0e1c-48cd-892e-4abd3df95ba8",
  "device": "sdk_gphone_x86_64_arm64-google",
  "disp_h": 2560,
  "disp_w": 1440,
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  "identity_link": {
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"sdk_protocol": "14",
"sdk_version": "AndroidTracker 3.7.3",
"nt_id": "d45c5-1-47dfae35-b398-40d2-a2e6-bd7bb40c88d0",
"data": {
  "screen_brightness": 0.4,
  "device_orientation": "portrait",
  "volume": 0.3333,
  "carrier_name": "Android",
  "adid": "827d8162-0e1c-48cd-892e-4abd3df95ba8",
  "device": "sdk_gphone_x86_64_arm64-google",
  "disp_h": 2560,
  "disp_w": 1440,
  "package": "com.audible.application",
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  "architecture": "x86_64",
  "battery_status": "not_charging",
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  "background_location": false,
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  "state_active": true,
  "app_limit_tracking": false,
  "identity_link": {
    "marketingcloudvisitorid":
      "14340173368323804205870968500570471451"
  }
},
"sdk_id": "c456-s26905-",
"send_date": "2021-01-13T14:42:17.885Z"
```

Audible on Android

POST https://control.kochava.com/track/json


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"action": "install",
"kochava_device_id": "KA3731610548931t77133e5ade9f4[…]",
"sdk_protocol": "14",
"sdk_version": "AndroidTracker 3.7.3",
"nt_id": "d45c5-1-47dfae35-b398-40d2-a2e6-bd7bb40c88d0",
"data": {
  "screen_brightness": 0.4,
  "device_orientation": "portrait",
  "volume": 0.3333,
  "carrier_name": "Android",
  "adid": "827d8162-0e1c-48cd-892e-4abd3df95ba8",
  "device": "sdk_gphone_x86_64_arm64-google",
  "disp_h": 2560,
  "disp_w": 1440,
  "package": "com.audible.application",
  "installed_date": 1610548859,
  "os_version": "Android 11",
  "device_limit_tracking": false,
  "is_genuine": false,
  "screen_dpi": 560,
  "screen_inches": 5,
  "manufacturer": "Google",
  "product_name": "sdk_gphone_x86_64_arm64",
  "architecture": "x86_64",
  "battery_status": "not_charging",
  "battery_level": 77,
  "device_cores": 2,
  "locale": "en-US",
  "timezone": "Europe/Berlin",
  "bluetooth_name": "sdk_gphone_x86_64_arm64",
  "ui_mode": "Normal",
  "notifications_enabled": true,
  "background_location": false,
  "bms": 1610548366742,
  "network_conn_type": "wifi",
  "network_metered": false,
  "usertime": 1610548931,
  "uptime": 6.764,
  "state_active": true,
  "app_limit_tracking": false,
  "identity_link": {
    "marketingcloudvisitorid":
      "14340173368323804205870968500570471451"
  }
},
"sdk_id": "c456-s26905-",
"send_date": "2021-01-13T14:42:17.885Z"
```

Audible on Android

POST https://control.kochava.com/track/json


```
"action": "install",
"kochava_device_id": "KA3731610548931t77133e5ade9f4[…]",
"sdk_protocol": "14",
"sdk_version": "AndroidTracker 3.7.3",
"nt_id": "d45c5-1-47dfae35-b398-40d2-a2e6-bd7bb40c88d0",
"data": {
  "screen_brightness": 0.4,
  "device_orientation": "portrait",
  "volume": 0.3333,
  "carrier_name": "Android",
  "adid": "827d8162-0e1c-48cd-892e-4abd3df95ba8",
  "device": "sdk_gphone_x86_64_arm64-google",
  "disp_h": 2560,
  "disp_w": 1440,
  "package": "com.audible.application",
  "installed_date": 1610548859,
  "os_version": "Android 11",
  "device_limit_tracking": false,
  "is_genuine": false,
  "screen_dpi": 560,
  "screen_inches": 5,
  "manufacturer": "Google",
  "product_name": "sdk_gphone_x86_64_arm64",
  "architecture": "x86_64",
  "battery_status": "not_charging",
  "battery_level": 77,
  "device_cores": 2,
  "locale": "en-US",
  "timezone": "Europe/Berlin",
  "bluetooth_name": "sdk_gphone_x86_64_arm64",
  "ui_mode": "Normal",
  "notifications_enabled": true,
  "background_location": false,
  "bms": 1610548366742,
  "network_conn_type": "wifi",
  "network_metered": false,
  "usertime": 1610548931,
  "uptime": 6.764,
  "state_active": true,
  "app_limit_tracking": false,
  "identity_link": {
    "marketingcloudvisitorid":
      "14340173368323804205870968500570471451"
  }
},
"sdk_id": "c456-s26905-",
"send_date": "2021-01-13T14:42:17.885Z"
```

Audible on Android

POST https://control.kochava.com/track/json


```
"action": "install",
"kochava_device_id": "KA3731610548931t77133e5ade9f4[…]",
"sdk_protocol": "14",
"sdk_version": "AndroidTracker 3.7.3",
"nt_id": "d45c5-1-47dfae35-b398-40d2-a2e6-bd7bb40c88d0",
"data": {
  "screen_brightness": 0.4,
  "device_orientation": "portrait",
  "volume": 0.3333,
  "carrier_name": "Android",
  "adid": "827d8162-0e1c-48cd-892e-4abd3df95ba8",
  "device": "sdk_gphone_x86_64_arm64-google",
  "disp_h": 2560,
  "disp_w": 1440,
  "package": "com.audible.application",
  "installed_date": 1610548859,
  "os_version": "Android 11",
  "device_limit_tracking": false,
  "is_genuine": false,
  "screen_dpi": 560,
  "screen_inches": 5,
  "manufacturer": "Google",
  "product_name": "sdk_gphone_x86_64_arm64",
  "architecture": "x86_64",
  "battery_status": "not_charging",
  "battery_level": 77,
  "device_cores": 2,
  "locale": "en-US",
  "timezone": "Europe/Berlin",
  "bluetooth_name": "sdk_gphone_x86_64_arm64",
  "ui_mode": "Normal",
  "notifications_enabled": true,
  "background_location": false,
  "bms": 1610548366742,
  "network_conn_type": "wifi",
  "network_metered": false,
  "usertime": 1610548931,
  "uptime": 6.764,
  "state_active": true,
  "app_limit_tracking": false,
  "identity_link": {
    "marketingcloudvisitorid":
      "14340173368323804205870968500570471451"
  }
},
"sdk_id": "c456-s26905-",
"send_date": "2021-01-13T14:42:17.885Z"
```

Detecting transmitted data

- String matching for known values (ad IDs, geolocation, honey data, …) can even work with encoded traffic as well after investing some effort (e.g. base64).

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- Problems:
  - Can never capture dynamic data types such as free disk space and current RAM usage, or low-entropy values like the operating system version.

Detecting transmitted data

- String matching for known values (ad IDs, geolocation, honey data, …) can even work with encoded traffic as well after investing some effort (e.g. base64).

- Problems:
  - Can never capture dynamic data types such as free disk space and current RAM usage, or low-entropy values like the operating system version.
  - Tracking data is often ridiculously nested and/or obfuscated.

POST https://outcome-ssp.supersonicads.com/mediation
?adUnit=2&sessionId=742FF763-3F0F-4F06-8FA1-792415932910
&appKey=82d752b5

H4sIAAAAAAAAE+VYWY/bNhB+z68w/GypPEWqbz4LI9kk6G7zUhcCLVJeNtYBit5kG+x/L23dXqdpDhTJ9smW5uPMcO
aboTgfno1GYyu2ezUe/Twal4dCGV++u/VTJbWwOs8idacyW44nR6QUVpyAHzbZaLQZS3WnY3WVS7XfHN9vxvr1bZ6p
cII340mF+XNbi6w5qPZtok1pr1VZOhOX5IdSmbW8uS9ULT2++EVlygirZAtL4/gkB/XzzuSHYi1nL+tVkICQ486ZYn
/Y6eyNMj27zIc+RD7yTAsT1p6EqH7eHjK5V2tZr4jz1BepyHKrSj8VOx1bvVdlt7wohiZCHyBnBKA+5Lm6r8UcSUbR
lrbSKq6vllc1YFoU+y42uozivChELUzEvuyEpdqlLmGtrwigMOiWZlaZTOxvVNlAXCqPsodBhHqB/y3T9r5VEOdZpu
IjMXqQdzrRLWKX2iudHVxoXiVJqapAQtRkSMg7ZawudbZrfWQErVYswB5egZVHViDw+GoKPRYiAmmIUQhBl/JsmPI6
VtcNAfMuD3k5TAMkPu/05FuXtLkwRitTA3LkyS6UA1d7210vVm9a0NZxRZkqkxA0Tumal5tx5/j7uauTM4cwgl3gKu
7++qb1lmLYk+vyhU61ncobI+K3zqlldixceal8tEzuviS46yM/SqutFvvlqfBPWn4/SkejD9VPRbNT6S5UYW+rvU86
4adIUqEKk99p2cb+quk456CdEWnqJPEjO6fWVDeRlkzz6YxDiGYepJh7ZLkMvemUhB7jc0JWjC8wxQMTQh4p3qv36r
XVqSsSkRaV2YCEgAEAMYasv/hw2mdrPQgABoQDb0tcoCFUsbcNw9gLZCAFILGKJYkgZIBQShAbOKLeW9jk/lR1U1lG
mLKQk2ACXQ944QKWRW5bgGAy6TA0ADRgvIdxTnJMHWYqr/JtRHmAg5BN4Op+q0yEAaMM4+EjHCgkkFM2UAghGLoREI
YI7mOcnhCFjVFEAWcU99SSEFICQX8JDzjg6JFa2L2ZwPmtMHab56V1bgBycrXFE8gYbEy6egEMgwlamzy7zg8mVhGC
bi+EDnaHnWN9JYggGgSsh0Eu4ZzjRxg6QVM5z/d5dn/EUObYgF7oxOZJEgWIopCEznzmvNERpZQDQCaDLPdPvpuLHA
Mud/yc5jXDkEtET7Q7nog6fi1cjZRNOx+Nuiq9eBg0kIfqz8PkUXnrzLmVxaqt388v73/sEGe134T935d+o2AqReFa
1rCtEh/7kH+nRf5NetaAEgD0t1QWrdq6d3wl/erd3xh3JpSPEvGVDLyQ0uvF8/N0Ah80ay6Q9aMLIXBEGIb/23O3aR
DfkLso/HLuIsJp8AS4W59yPwh3H/fLz2drTfP/U6PFGDH6FMhafYA9PbL+x98B31kvxZg8CXrWt4EfhJ6fPM5rth5/
//jiba6yMUlcqzZsLOQ5xcyW3f9VqlgeTO7puNj/NlNm3ZGsv4OtmlFBdwM+HR1HyLrprdwFD37EMJt01vZRvL82Xuq
nC1jZs7w1tvpgHm/FeZLuD2DUFuHzpLZadtYNulbp70BzMV14wY07pjCy9kM6WHl8wzBcEBatpt66av3UzlYgRlCQs
wDgBCUlAwBMBL44QPlZKrgI22cP42cPf7GKrk3QUAAA=

Recipe

From Base64

Alphabet
A-Za-z0-9+/=

Remove non-alphabet chars Strict mode

Input

length: 1664
lines: 1

```
H4sIAAAAAAAAE+VYWY/bNhB+z68w/GypPEWqbz4LI9kk6G7zUhcCLVJeNtYBit5kG+x/L23dXqdpDhTJ9smW5uPMcOaboTgfno1GYyu2ezUe
/Twal4dCGV++u
/VTJbWwOs8idacyW44nR6QUVpyAHzbZaLQZS3WnY3WVS7XfHN9vxvr1bZ6pcII340mF+XNbi6w5qPZtok1pr1VZOhOX5IdSmbW8uS9ULT2++EVlygirZA
tL4/gkB/XzzuSHYi1nL+tVkICQ486ZYn
```

Output

time: 3ms
length: 1247
lines: 3

```
..........åXY.Û6.~Ï¯0ül©<Eªo>.#Ù$ènóR..-R^6Ö..Þd.ì./mÝ^§i..ÉöÉ.æãÌpæ.¡8...Fc+¶
{5.ý<...B._¾»õS%µ°:Ï"u§2[.'G¤.V...6Ùh´.Ku§cu.Kµß.ßoÆúõm.©p.7ãI.ùs[.¬9¨öm¢Mi¯UY:..ä.R.µ¼¹/T-=¾øEeÊ.«d.Kãø$.õóÎä.b-
g/ëU...ãÎ.b.Øéì.2=»Ì.>D>òL..Ö..¨~Þ.2¹WkY¯.óÔ.©Èr«J?.;.[½We·¼(.&B. g. >ä¹º¯Å.IFÑ.¶Ò*®¯.W5`Z.û.6º.â¼(D-
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.ó..y9L.$>ïôä[.´¹0F+S.räÉ...W{Û]/VoZÐÖqE.*..4Né...qçøû¹«.3.0.]à*îþú¦õ.bØ.ëò.Nµ.Ê.#â·Î©ev,\y©|´Lî¾$¸ë#?J«..ûå©ðOZ~?JG£
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..¬.A.á.ãG.:AS9Ï÷yv.ÄPæØ.^èÄæI...¢..Î|æ¼Ñ.¥..@&.,÷O¾.....wü.æ5Ã.KDO´;..:~-\..M;..º*½x.4..êÏÃäQyëÌ¹.Åª.ßÏ/ï.ì.gµß.ýß.~
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[.r?.w.÷ËÏgkMóÿS£Å.1ú.ÈZ}.==²þÇß.ßY/Å.< zÖ·.....<Îk¶..þ8.k¬.RW*Í..9.qs%·.Õj...;ºn6?Í.Ù·dk/àëf.P]ÀÏ.GQò.ºkw.Cß±.&Ý5½.o
/Í.º©ÂÖ6lï
m¾...ñ^d».Ø5.¸|é-..µ.n.º{Ð.ÌW^0cNé.,½.Î.._0Ì...«i·®.¿u3....$,À8.        I@À../..>VJ®.6ÙÃøÙÃßìb«.t...
```

Recipe

From Base64

Alphabet
A-Za-z0-9+/=

☑ Remove non-alphabet chars ☐ Strict mode

Gunzip

Input

length: 1664
lines: 1

H4sIAAAAAAAAE+VYWY/bNhB+z68w/GypPEWqbz4LI9kk6G7zUhcCLVJeNtYBit5kG+x/L23dXqdpDhTJ9smW5uPMcOaboTgfno1GYyu2ezUe
/Twal4dCGV++u
/VTJbWwOs8idacyW44nR6QUVpyAHzbZaLQZS3WnY3WVS7XfHN9vxvr1bZ6pcII340mF+XNbi6w5qPZtok1pr1VZOhOX5IdSmbW8uS9ULT2++EVlygirZA
tL4/gkB/XzzuSHYi1nL+tVkICQ486ZYn

Output

start: 51 time: 5ms
end: 51 length: 5236
length: 0 lines: 4

{
  "table" : "super.dwh.mediation_events",
  "data" : "{\n \"deviceModel\" : \"iPhone9,3\",\n \"jb\" : \"true\",\n \"firstSession\" : \"true\",\n
\"userIdType\" : \"userGenerated\",\n \"mcc\" : 0,\n \"groupIdBN\" : \"1409833\",\n \"pluginVersion\" :
\"7.1.12.2-r\",\n \"att\" : 2,\n \"bundleId\" : \"com.amanotes.magictiles\",\n \"appVersion\" : \"9.021.102\",\n
\"appKey\" : \"82d752b5\",\n \"deviceOEM\" : \"Apple\",\n \"is_coppa\" : \"false\",\n \"segmentId\" : \"20296\",\n
\"internalTestId\" : {\n\n },\n \"pluginType\" : \"Unity\",\n \"connectionType\" : \"wifi\",\n
\"gmtMinutesOffset\" : 120,\n \"advertisingId\" : \"742FF763-3F0F-4F06-8FA1-792415932910\",\n \"mnc\" : 0,\n
\"deviceOS\" : \"ios\",\n \"osVersion\" : \"14.8\",\n \"mobileCarrier\" : \"o2-de\",\n \"advertisingIdType\" :
\"IDFV\",\n \"battery\" : 100,\n \"icc\" : \"0\",\n \"xCodeVersion\" : \"1321\",\n \"groupIdRV\" : \"1453121\",\n
\"isLimitAdTrackingEnabled\" : \"true\",\n \"idfv\" : \"742FF763-3F0F-4F06-8FA1-792415932910\",\n
\"InterstitialEvents\" : [\n   {\n   \"sessionDepth\" : 1,\n   \"connectionType\" : \"wifi\",\n
\"provider\" : \"Mediation\",\n   \"programmatic\" : 1,\n   \"eventSessionId\" : \"CAB8112B-1538-4EE9-
AA49-78C44F78D353\",\n   \"adUnit\" : 2,\n   \"timestamp\" : 1649070013317,\n   \"auctionId\" : \"66030480-
b406-11ec-b99c-6d6da04cecd4_1170455427\",\n   \"ext1\" :
\"1UnityAds_3579846,1AppLovin_5380434,1UnityAds_5605678,1AppLovin_3178354,1AdMob_5863697,1Fyber_3075733,1Fyber_307573
1,1UnityAds_5641857,1AppLovin_3111046,1AppLovin_5647243,1AppLovin_3075929,1AdMob_2508753,1UnityAds_4915410,1AppLovin_
3868082,1AppLovin_5647241,1AppLovin,1Chartboost_3104731,1AppLovin_41771,1AdMob_3120730,2IronSource_2141845,1UnityAds_
5638751,1AppLovin_2425667,1UnityAds_2164883,1AppLovin_2425665,2AdColony_2165717,2Liftoff_6252949,2InMobi_5558004,\",\
n   \"firstSessionTimestamp\" : 1649070007838,\n   \"eventId\" : 2311,\n   \"genericParams\" : {\n
\"segmentId\" : \"20296\"\n   }\n   },\n   {\n   \"instanceType\" : 1,\n   \"connectionType\" :
\"wifi\",\n   \"sessionDepth\" : 1,\n   \"provider\" : \"UnityAds\",\n   \"programmatic\" : 1,\n
\"providerAdapterVersion\" : \"4.3.18\",\n   \"adUnit\" : 2,\n   \"timestamp\" : 1649070013317,\n
\"auctionId\" : \"66030480-b406-11ec-b99c-6d6da04cecd4_1170455427\",\n   \"eventSessionId\" : \"CAB8112B-
1538-4EE9-AA49-78C44F78D353\",\n   \"eventId\" : 2002,\n   \"spId\" : \"3579846\",\n
\"firstSessionTimestamp\" : 1649070007838,\n   \"auctionTrials\" : 1,\n   \"genericParams\" : {\n
\"segmentId\" : \"20296\"\n   },\n   \"providerSDKVersion\" : \"4.0.0\"\n   },\n   {\n
\"providerSDKVersion\" : \"10.3.7\",\n   \"connectionType\" : \"wifi\",\n   \"sessionDepth\" : 1,\n
\"provider\" : \"AppLovin\",\n   \"programmatic\" : 1,\n   \"providerAdapterVersion\" : \"4.3.29\",\n

Recipe

From Base64

Alphabet
A-Za-z0-9+/=

☑ Remove non-alphabet chars ☐ Strict mode

Gunzip

JPath expression

Query
data

Result delimiter
\n

☑ Prevent eval

Input

length: 1664
lines: 1

H4sIAAAAAAAE+VYWY/bNhB+z68w/GypPEWqbz4LI9kk6G7zUhcCLVJeNtYBit5kG+x/L23dXqdpDhTJ9smW5uPMcOaboTgfno1GYyu2ezUe
/Twal4dCGV++u
/VTJbWwOs8idacyW44nR6QUVpyAHzbZaLQZS3WnY3WVS7XfHN9vxvr1bZ6pcII340mF+XNbi6w5qPZtok1pr1VZOhOX5IdSmbW8uS9ULT2++EVlygirZA
tL4/gkB/XzzuSHYi1nL+tVkICQ486ZYn

Output

time: 3ms
length: 5178
lines: 1

"{\n \"deviceModel\" : \"iPhone9,3\",\n \"jb\" : \"true\",\n \"firstSession\" : \"true\",\n \"userIdType\" :
\"userGenerated\",\n \"mcc\" : 0,\n \"groupIdBN\" : \"1409833\",\n \"pluginVersion\" : \"7.1.12.2-r\",\n \"att\"
: 2,\n \"bundleId\" : \"com.amanotes.magictiles\",\n \"appVersion\" : \"9.021.102\",\n \"appKey\" :
\"82d752b5\",\n \"deviceOEM\" : \"Apple\",\n \"is_coppa\" : \"false\",\n \"segmentId\" : \"20296\",\n
\"internalTestId\" : {\n\n },\n \"pluginType\" : \"Unity\",\n \"connectionType\" : \"wifi\",\n
\"gmtMinutesOffset\" : 120,\n \"advertisingId\" : \"742FF763-3F0F-4F06-8FA1-792415932910\",\n \"mnc\" : 0,\n
\"deviceOS\" : \"ios\",\n \"osVersion\" : \"14.8\",\n \"mobileCarrier\" : \"o2-de\",\n \"advertisingIdType\" :
\"IDFV\",\n \"battery\" : 100,\n \"icc\" : \"0\",\n \"xCodeVersion\" : \"1321\",\n \"groupIdRV\" : \"1453121\",\n
\"isLimitAdTrackingEnabled\" : \"true\",\n \"idfv\" : \"742FF763-3F0F-4F06-8FA1-792415932910\",\n
\"InterstitialEvents\" : [\n {\n \"sessionDepth\" : 1,\n \"connectionType\" : \"wifi\",\n
\"provider\" : \"Mediation\",\n \"programmatic\" : 1,\n \"eventSessionId\" : \"CAB8112B-1538-4EE9-
AA49-78C44F78D353\",\n \"adUnit\" : 2,\n \"timestamp\" : 1649070013317,\n \"auctionId\" : \"66030480-
b406-11ec-b99c-6d6da04cecd4_1170455427\",\n \"ext1\" :
\"1UnityAds_3579846,1AppLovin_5380434,1UnityAds_5605678,1AppLovin_3178354,1AdMob_5863697,1Fyber_3075733,1Fyber_307573
1,1UnityAds_5641857,1AppLovin_3111046,1AppLovin_5647243,1AppLovin_3075929,1AdMob_2508753,1UnityAds_4915410,1AppLovin_
3868082,1AppLovin_5647241,1AppLovin,1Chartboost_3104731,1AppLovin_41771,1AdMob_3120730,2IronSource_2141845,1UnityAds_
5638751,1AppLovin_2425667,1UnityAds_2164883,1AppLovin_2425665,2AdColony_2165717,2Liftoff_6252949,2InMobi_5558004,\",\
n \"firstSessionTimestamp\" : 1649070007838,\n \"eventId\" : 2311,\n \"genericParams\" : {\n
\"segmentId\" : \"20296\"\n }\n },\n {\n \"instanceType\" : 1,\n \"connectionType\" :
\"wifi\",\n \"sessionDepth\" : 1,\n \"provider\" : \"UnityAds\",\n \"programmatic\" : 1,\n
\"providerAdapterVersion\" : \"4.3.18\",\n \"adUnit\" : 2,\n \"timestamp\" : 1649070013317,\n
\"auctionId\" : \"66030480-b406-11ec-b99c-6d6da04cecd4_1170455427\",\n \"eventSessionId\" : \"CAB8112B-
1538-4EE9-AA49-78C44F78D353\",\n \"eventId\" : 2002,\n \"spId\" : \"3579846\",\n
\"firstSessionTimestamp\" : 1649070007838,\n \"auctionTrials\" : 1,\n \"genericParams\" : {\n
\"segmentId\" : \"20296\"\n },\n \"providerSDKVersion\" : \"4.0.0\"\n },\n {\n
\"providerSDKVersion\" : \"10.3.7\",\n \"connectionType\" : \"wifi\",\n \"sessionDepth\" : 1,\n
\"provider\" : \"AppLovin\",\n \"programmatic\" : 1,\n \"providerAdapterVersion\" : \"4.3.29\",\n
\"adUnit\" : 2,\n \"timestamp\" : 1649070024856,\n \"auctionId\" : \"66030480-b406-11ec-
b99c-6d6da04cecd4_1170455427\",\n \"eventSessionId\" : \"CAB8112B-1538-4EE9-AA49-78C44F78D353\",\n

Recipe

From Base64

Alphabet
A-Za-z0-9+/=

☑ Remove non-alphabet chars ☐ Strict mode

Gunzip

JPath expression

Query
data

Result delimiter
\n

☑ Prevent eval

JSON Parse

JSON Beautify

Indent string

☐ Sort Object Keys

☑ Formatted

Input

length: 1664
lines: 1

H4sIAAAAAAAE+VYWY/bNhB+z68w/GypPEWqbz4LI9kk6G7zUhcCLVJeNtYBit5kG+x/L23dXqdpDhTJ9smW5uPMcOaboTgfno1GYyu2ezUe
/Twal4dCGV++u
/VTJbWwOs8idacyW44nR6QUVpyAHzbZaLQZS3WnY3WVS7XfHN9vxvr1bZ6pcII340mF+XNbi6w5qPZtok1pr1VZOhOX5IdSmbW8uS9ULT2++EVlygirZA
tL4/gkB/XzzuSHYi1nL+tVkICQ486ZYn

Output

time: 10ms
length: 5169
lines: 141


```
{
    deviceModel: "iPhone9,3",
    jb: "true",
    firstSession: "true",
    userIdType: "userGenerated",
    mcc: 0,
    groupIdBN: "1409833",
    pluginVersion: "7.1.12.2-r",
    att: 2,
    bundleId: "com.amanotes.magictiles",
    appVersion: "9.021.102",
    appKey: "82d752b5",
    deviceOEM: "Apple",
    is_coppa: "false",
    segmentId: "20296",
    internalTestId: {},
    pluginType: "Unity",
    connectionType: "wifi",
    gmtMinutesOffset: 120,
    advertisingId: "742FF763-3F0F-4F06-8FA1-792415932910",
    mnc: 0,
    deviceOS: "ios",
    osVersion: "14.8",
    mobileCarrier: "o2-de",
    advertisingIdType: "IDFV",
    battery: 100,
```


view in CyberChef

POST https://graph.facebook.com/v12.0

{"batch":"[{\"relative_url\":\"313732607382406\\\/activities?access_token=313732607382406%7C7e5f1e2769be769bb6710ffbc14399c2&advertiser_id_collection_enabled=1&anon_id=XZ0BAE1D89-562C-4B77-9D29-29E9E80F3051&application_tracking_enabled=1&custom_events=%5B%7B%22_eventName%22%3A%22Backend_OK%22%2C%22_logTime%22%3A1650911380%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADReport_RequstError%22%2C%22_logTime%22%3A1650911382%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADReport_RequstStart%22%2C%22_logTime%22%3A1650911382%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADReport_RequstError%22%2C%22_logTime%22%3A1650911383%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADReport_RequstStart%22%2C%22_logTime%22%3A1650911383%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADReport_RequstError%22%2C%22_logTime%22%3A1650911383%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADStart_RequstError%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADStart_RequstStart%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstStart%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstError%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADStart_RequstError%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADStart_RequstStart%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstStart%22%2C%22_logTime%22%3A1650911385%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstError%22%2C%22_logTime%22%3A1650911385%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigation

Recipe

JPath expression

Query
batch

Result delimiter
\n

Prevent eval

Input

length: 4151
lines: 1

{"batch":"[{\"relative_url\":\"313732607382406
\\\/activities?access_token=313732607382406%7C7e5f1e2769be769bb6710ffbc14399c2&advertiser_id_collection_enabled=1&
anon_id=XZ0BAE1D89-562C-4B77-9D29-29E9E80F3051&application_tracking_enabled=1&custom_events=%5B%7B%22_eventName%22%3A
%22Backend_OK%22%2C%22_logTime%22%3A1650911380%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D

Output

time: 1ms
length: 4107
lines: 1

"[{\"relative_url\":\"313732607382406\\\/activities?access_token=313732607382406%7C7e5f1e2769be769bb6710ffbc14399c2&
advertiser_id_collection_enabled=1&anon_id=XZ0BAE1D89-562C-4B77-9D29-29E9E80F3051&application_tracking_enabled=1&
custom_events=%5B%7B%22_eventName%22%3A%22Backend_OK%22%2C%22_logTime%22%3A1650911380%2C%22_valueToSum%22%3A1
%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADReport_RequstError%22%2C%22_logTime
%22%3A1650911382%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A
%22ADReport_RequstStart%22%2C%22_logTime%22%3A1650911382%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADReport_RequstError%22%2C%22_logTime%22%3A1650911383
%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A
%22ADReport_RequstStart%22%2C%22_logTime%22%3A1650911383%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADReport_RequstError%22%2C%22_logTime%22%3A1650911383
%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADStart_RequstError
%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B
%22_eventName%22%3A%22ADStart_RequstStart%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstStart%22%2C%22_logTime%22%3A1650911384
%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstError
%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B
%22_eventName%22%3A%22ADStart_RequstError%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
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%22%2C%22_logTime%22%3A1650911385%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B
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%22_eventName%22%3A%22ADOpen_RequstStart%22%2C%22_logTime%22%3A1650911388%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
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%22ADStart_RequstSuccess%22%2C%22_logTime%22%3A1650911392%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstSuccess%22%2C%22_logTime%22%3A1650911392

Recipe

JPath expression

Query
batch

Result delimiter
\n

Prevent eval

JSON Parse

Input

length: 4151
lines: 1

{"batch":"[{\"relative_url\":\"313732607382406
\\\/activities?access_token=313732607382406%7C7e5f1e2769be769bb6710ffbc14399c2&advertiser_id_collection_enabled=1&
anon_id=XZ0BAE1D89-562C-4B77-9D29-29E9E80F3051&application_tracking_enabled=1&custom_events=%5B%7B%22_eventName%22%3A
%22Backend_OK%22%2C%22_logTime%22%3A1650911380%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D

Output

time: 4ms
length: 4088
lines: 1

[{"relative_url":"313732607382406\/activities?access_token=313732607382406%7C7e5f1e2769be769bb6710ffbc14399c2&
advertiser_id_collection_enabled=1&anon_id=XZ0BAE1D89-562C-4B77-9D29-29E9E80F3051&application_tracking_enabled=1&
custom_events=%5B%7B%22_eventName%22%3A%22Backend_OK%22%2C%22_logTime%22%3A1650911380%2C%22_valueToSum%22%3A1
%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADReport_RequstError%22%2C%22_logTime
%22%3A1650911382%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A
%22ADReport_RequstStart%22%2C%22_logTime%22%3A1650911382%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADReport_RequstError%22%2C%22_logTime%22%3A1650911383
%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A
%22ADReport_RequstStart%22%2C%22_logTime%22%3A1650911383%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADReport_RequstError%22%2C%22_logTime%22%3A1650911383
%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADStart_RequstError
%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B
%22_eventName%22%3A%22ADStart_RequstStart%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstStart%22%2C%22_logTime%22%3A1650911384
%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstError
%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B
%22_eventName%22%3A%22ADStart_RequstError%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
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%22%2C%22_logTime%22%3A1650911387%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B
%22_eventName%22%3A%22ADOpen_RequstStart%22%2C%22_logTime%22%3A1650911388%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstError%22%2C%22_logTime%22%3A1650911388
%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A
%22ADStart_RequstSuccess%22%2C%22_logTime%22%3A1650911392%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstSuccess%22%2C%22_logTime%22%3A1650911392

Recipe

JPath expression

Query
batch

Result delimiter
\n

Prevent eval

JSON Parse

JPath expression

Query
*.relative_url

Result delimiter
\n

Prevent eval

Input

length: 4151
lines: 1

{"batch":"[{\"relative_url\":\"313732607382406
\\\/activities?access_token=313732607382406%7C7e5f1e2769be769bb6710ffbc14399c2&advertiser_id_collection_enabled=1&
anon_id=XZ0BAE1D89-562C-4B77-9D29-29E9E80F3051&application_tracking_enabled=1&custom_events=%5B%7B%22_eventName%22%3A
%22Backend_OK%22%2C%22_logTime%22%3A1650911380%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D

Output

time: 1ms
length: 4020
lines: 2

"313732607382406/activities?access_token=313732607382406%7C7e5f1e2769be769bb6710ffbc14399c2&
advertiser_id_collection_enabled=1&anon_id=XZ0BAE1D89-562C-4B77-9D29-29E9E80F3051&application_tracking_enabled=1&
custom_events=%5B%7B%22_eventName%22%3A%22Backend_OK%22%2C%22_logTime%22%3A1650911380%2C%22_valueToSum%22%3A1
%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADReport_RequstError%22%2C%22_logTime
%22%3A1650911382%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A
%22ADReport_RequstStart%22%2C%22_logTime%22%3A1650911382%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
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%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A
%22ADReport_RequstStart%22%2C%22_logTime%22%3A1650911383%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADReport_RequstError%22%2C%22_logTime%22%3A1650911383
%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADStart_RequstError
%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B
%22_eventName%22%3A%22ADStart_RequstStart%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
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%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstError
%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B
%22_eventName%22%3A%22ADStart_RequstError%22%2C%22_logTime%22%3A1650911384%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADStart_RequstStart%22%2C%22_logTime%22%3A1650911384
%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstStart
%22%2C%22_logTime%22%3A1650911385%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B
%22_eventName%22%3A%22ADOpen_RequstError%22%2C%22_logTime%22%3A1650911385%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstStart%22%2C%22_logTime%22%3A1650911387
%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstError
%22%2C%22_logTime%22%3A1650911387%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B
%22_eventName%22%3A%22ADOpen_RequstStart%22%2C%22_logTime%22%3A1650911388%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstError%22%2C%22_logTime%22%3A1650911388
%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A
%22ADStart_RequstSuccess%22%2C%22_logTime%22%3A1650911392%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A
%22UINavigationController%22%7D%2C%7B%22_eventName%22%3A%22ADOpen_RequstSuccess%22%2C%22_logTime%22%3A1650911392

Recipe

JPath expression

Query
batch

Result delimiter
\n

Prevent eval

JSON Parse

JPath expression

Query
*.relative_url

Result delimiter
\n

Prevent eval

Query String Decode

Depth
5

Parameter limit
1000

Delimiter
&

Allow dot notation?

Allow comma arrays?

JSON Beautify

Indent string

Input

length: 4151
lines: 1

{"batch":"[{\"relative_url\":\"313732607382406
\\\/activities?access_token=313732607382406%7C7e5f1e2769be769bb6710ffbc14399c2&advertiser_id_collection_enabled=1&
anon_id=XZ0BAE1D89-562C-4B77-9D29-29E9E80F3051&application_tracking_enabled=1&custom_events=%5B%7B%22_eventName%22%3A
%22Backend_OK%22%2C%22_logTime%22%3A1650911380%2C%22_valueToSum%22%3A1%2C%22_ui%22%3A%22UINavigationController%22%7D

Output

time: 10ms
length: 3461
lines: 24

{
"313732607382406/activities?access_token": "313732607382406|7e5f1e2769be769bb6710ffbc14399c2",
advertiser_id_collection_enabled: "1",
anon_id: "XZ0BAE1D89-562C-4B77-9D29-29E9E80F3051",
application_tracking_enabled: "1",
custom_events: "[{\"_eventName\":\"Backend_OK\",\"_logTime\":1650911380,\"_valueToSum\":1,\"_ui
\":\"UINavigationController\"},{\"_eventName\":\"ADReport_RequstError\",\"_logTime\":1650911382,
\"_valueToSum\":1,\"_ui\":\"UINavigationController\"},{\"_eventName\":\"ADReport_RequstStart\",\"_logTime
\":1650911382,\"_valueToSum\":1,\"_ui\":\"UINavigationController\"},{\"_eventName\":\"ADReport_RequstError
\",\"_logTime\":1650911383,\"_valueToSum\":1,\"_ui\":\"UINavigationController\"},{\"_eventName
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\"},{\"_eventName\":\"ADReport_RequstError\",\"_logTime\":1650911383,\"_valueToSum\":1,\"_ui
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\"_valueToSum\":1,\"_ui\":\"UINavigationController\"},{\"_eventName\":\"ADOpen_RequstStart\",\"_logTime
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\"},{\"_eventName\":\"ADStart_RequstStart\",\"_logTime\":1650911384,\"_valueToSum\":1,\"_ui
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\":1,\"_ui\":\"UINavigationController\"},{\"_eventName\":\"ADOpen_RequstError\",\"_logTime\":1650911385,
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\":\"ADOpen_RequstStart\",\"_logTime\":1650911388,\"_valueToSum\":1,\"_ui\":\"UINavigationController
\"},{\"_eventName\":\"ADOpen_RequstError\",\"_logTime\":1650911388,\"_valueToSum\":1,\"_ui

view in CyberChef

Requests	Endpoint
4098	https://digitalassetlinks.googleapis.com/google.digitalassetlinks.v1.AssetLinks/Check
3015	https://app-measurement.com/a
2154	https://googleads.g.doubleclick.net/mads/gma
1836	https://csi.gstatic.com/csi
1643	https://csi.gstatic.com/csi
1543	https://googleads.g.doubleclick.net/pagead/interaction/
1214	https://googleads.g.doubleclick.net/favicon.ico
1212	https://fcmtoken.googleapis.com/register
1087	https://googleads.g.doubleclick.net/getconfig/pubsetting
1069	https://fonts.googleapis.com/css
1028	https://firebaselogging-pa.googleapis.com/v1/firelog/legacy/batchlog
1024	https://prod-ms.applovin.com/1.0/event/lerr
987	https://googleads.g.doubleclick.net/mads/static/mad/sdk/native/sdk-core-v40-loader.js
986	https://googleads.g.doubleclick.net/mads/static/mad/sdk/native/sdk-core-v40-loader.appcache
953	https://googleads.g.doubleclick.net/mads/static/mad/sdk/native/production/sdk-core-v40-impl.js
845	https://logs.ironsrc.mobi/logs
783	https://pagead2.googlesyndication.com/pagead/gen_204
753	https://www.facebook.com/adnw_sync2
719	https://www.googletagservices.com/activeview/js/current/lidar.js
675	https://googleads.g.doubleclick.net/mads/static/mad/sdk/native/production/sdk-core-v40-impl.html

26 adapters for
specific endpoints are
enough to cover
10 % of the *entire* traffic.

README.md

TrackHAR

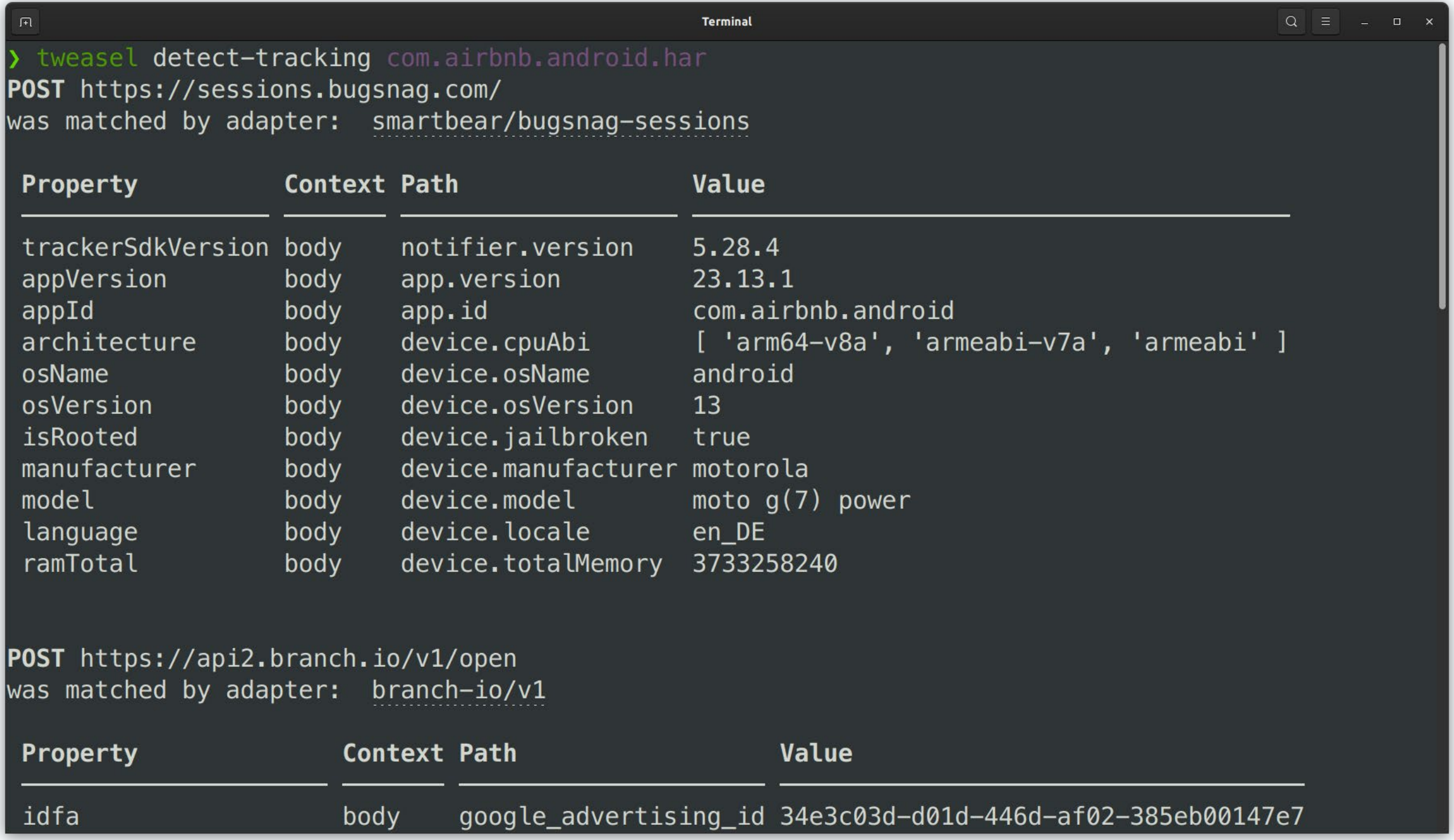
> Library for detecting tracking data transmissions from traffic in HAR format.

For research into mobile privacy and complaints against tracking, it is important to know what data is being transmitted in a request to a tracking server. But these requests are in a huge variety of different formats and often heavily nested and/or obfuscated, which hinders straightforward automatic analysis. TrackHAR aims to address this problem. It takes recorded traffic in a HAR files as the input and returns a parsed list of the transmitted data (and, optionally, additional metadata like the tracking company and location in the data) for each request it can handle.

To achieve this, TrackHAR uses adapters written for specific tracking endpoints. In our research, we have found that generic approaches (like indicator matching in the raw transmitted plain text or base64-encoded request content) are not sufficient due to the frankly ridiculous nesting and obfuscation we observed. In addition, approaches that search for static honey data values can never capture dynamic data types such as free disk space and current RAM usage, or low-entropy values like the operating system version (e.g. `11`).
However, we have also noticed that there is a comparatively small number of tracking endpoints which make up a large portion of all app traffic. This makes our adapter-based approach feasible to detect most of the transmitted tracking data. But it will never be possible to write an adapter for every request. As such, we plan to implement support for indicator matching as a fallback for requests not covered by any adapter in the future.

An important additional goal of TrackHAR is to produce outputs that make it possible to automatically generate human-readable documentation that allows people to comprehend why we detected each data transmission. This is especially important to submit complaints against illegal tracking to the data protection authorities. The generation of these reports is not handled by TrackHAR itself

https://github.com/tweaselORG/TrackHAR


Terminal
❯ tweasel detect-tracking com.airbnb.android.har
POST https://sessions.bugsnag.com/
was matched by adapter: smartbear/bugsnag-sessions
Property Context Path Value
trackerSdkVersion body notifier.version 5.28.4
appVersion body app.version 23.13.1
appId body app.id com.airbnb.android
architecture body device.cpuAbi ['arm64-v8a', 'armeabi-v7a', 'armeabi']
osName body device.osName android
osVersion body device.osVersion 13
isRooted body device.jailbroken true
manufacturer body device.manufacturer motorola
model body device.model moto g(7) power
language body device.locale en_DE
ramTotal body device.totalMemory 3733258240
POST https://api2.branch.io/v1/open
was matched by adapter: branch-io/v1
Property Context Path Value
idfa body google_advertising_id 34e3c03d-d01d-446d-af02-385eb00147e7

What do these adapters look like?

```
{
    slug: 'graph',
    tracker: {
        slug: 'facebook',
        name: 'Meta Platforms Ireland Limited',
        datenanfragenSlug: 'facebook',
    },

    endpointUrls: [/^https:\/\/graph\.facebook\.com\/v\d{1,2}.\d$/],
    match: (r) => r.content?.startsWith('{"'),

    decodingSteps: [
        { function: 'parseJson', input: 'body', output: 'b' },
        { function: 'parseJson', input: 'b.batch', output: 'batch' },
        { function: 'getProperty', mapInput: 'batch',
          options: { path: 'relative_url' }, output: 'relativeUrls' },
        { function: 'parseQueryString', mapInput: 'relativeUrls', output: 'res.body.batch' },
        { function: 'getProperty', input: 'b',
          options: { path: 'batch_app_id' }, output: 'res.body.batch_app_id' },
    ],
    containedDataPaths: {
        trackerSdkVersion: {
            context: 'body'
```

What do these adapters look like?

```
{
    slug: 'graph',
    tracker: {
        slug: 'facebook',
        name: 'Meta Platforms Ireland Limited',
        datenanfragenSlug: 'facebook',
    },

    endpointUrls: [/^https:\/\/graph\.facebook\.com\/v\d{1,2}.\d$/],
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          options: { path: 'relative_url' }, output: 'relativeUrls' },
        { function: 'parseQueryString', mapInput: 'relativeUrls', output: 'res.body.batch' },
        { function: 'getProperty', input: 'b',
          options: { path: 'batch_app_id' }, output: 'res.body.batch_app_id' },
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    containedDataPaths: {
        trackerSdkVersion: {
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        slug: 'facebook',
        name: 'Meta Platforms Ireland Limited',
        datenanfragenSlug: 'facebook',
    },

    endpointUrls: [/^https:\/\/graph\.facebook\.com\/v\d{1,2}.\d$/],
    match: (r) => r.content?.startsWith('{"'),

    decodingSteps: [
        { function: 'parseJson', input: 'body', output: 'b' },
        { function: 'parseJson', input: 'b.batch', output: 'batch' },
        { function: 'getProperty', mapInput: 'batch',
          options: { path: 'relative_url' }, output: 'relativeUrls' },
        { function: 'parseQueryString', mapInput: 'relativeUrls', output: 'res.body.batch' },
        { function: 'getProperty', input: 'b',
          options: { path: 'batch_app_id' }, output: 'res.body.batch_app_id' },
    ],
    containedDataPaths: {
        trackerSdkVersion: {
            context: 'body'
```

What do these adapters look like?

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{
    slug: 'graph',
    tracker: {
        slug: 'facebook',
        name: 'Meta Platforms Ireland Limited',
        datenanfragenSlug: 'facebook',
    },

    endpointUrls: [/^https:\/\/graph\.facebook\.com\/v\d{1,2}.\d$/],
    match: (r) => r.content?.startsWith('{"'),

    decodingSteps: [
        { function: 'parseJson', input: 'body', output: 'b' },
        { function: 'parseJson', input: 'b.batch', output: 'batch' },
        { function: 'getProperty', mapInput: 'batch',
          options: { path: 'relative_url' }, output: 'relativeUrls' },
        { function: 'parseQueryString', mapInput: 'relativeUrls', output: 'res.body.batch' },
        { function: 'getProperty', input: 'b',
          options: { path: 'batch_app_id' }, output: 'res.body.batch_app_id' },
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        name: 'Meta Platforms Ireland Limited',
        datenanfragenSlug: 'facebook',
    },

    endpointUrls: [/^https:\/\/graph\.facebook\.com\/v\d{1,2}.\d$/],
    match: (r) => r.content?.startsWith('{"'),

    decodingSteps: [
        { function: 'parseJson', input: 'body', output: 'b' },
        { function: 'parseJson', input: 'b.batch', output: 'batch' },
        { function: 'getProperty', mapInput: 'batch',
          options: { path: 'relative_url' }, output: 'relativeUrls' },
        { function: 'parseQueryString', mapInput: 'relativeUrls', output: 'res.body.batch' },
        { function: 'getProperty', input: 'b',
          options: { path: 'batch_app_id' }, output: 'res.body.batch_app_id' },
    ],
    containedDataPaths: {
        trackerSdkVersion: {
            context: 'body'
```

What do these adapters look like?

```
      options: { path: 'batch_app_id' }, output: 'res.body.batch_app_id' },
  ],
  containedDataPaths: {
      trackerSdkVersion: {
          context: 'body',
          path: 'batch.*.sdk_version',
          reasoning: 'obvious property name',
      },

      idfa: {
          context: 'body',
          path: 'batch.*.advertiser_id',
          reasoning: 'obvious property name',
      },

      otherIdentifiers: {
          context: 'body',
          path: 'batch.*.anon_id',
          reasoning: 'obvious property name',
      },

      osName: [
          {
```

What do these adapters look like?

```
        options: { path: 'batch_app_id' }, output: 'res.body.batch_app_id' },
    ],
    containedDataPaths: {
        trackerSdkVersion: {
            context: 'body',
            path: 'batch.*.sdk_version',
            reasoning: 'obvious property name',
        },

        idfa: {
            context: 'body',
            path: 'batch.*.advertiser_id',
            reasoning: 'obvious property name',
        },

        otherIdentifiers: {
            context: 'body',
            path: 'batch.*.anon_id',
            reasoning: 'obvious property name',
        },

        osName: [
            {
```

What do these adapters look like?

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      options: { path: 'batch_app_id' }, output: 'res.body.batch_app_id' },
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    trackerSdkVersion: {
        context: 'body',
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        context: 'body',
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        reasoning: 'obvious property name',
    },

    otherIdentifiers: {
        context: 'body',
        path: 'batch.*.anon_id',
        reasoning: 'obvious property name',
    },

    osName: [
        {
```

graph

operated by: Facebook (get company information on datarequests.org)

Endpoint URLs

These are URLs or regexes of endpoints the tracker sends data to. We use these to determine which adapter to apply to a request. Some trackers use the same endpoint for several formats. In this case we use additional logic to match the adapter to the request, refer to the code for more information.

- `/^https:\/\/graph\.facebook\.com\/v\d{1,2}.\d$/`

Decoding steps

Every tracking library has its own way of transmitting tracking data, often even several. They are regularly pretty convoluted, nested encoding schemes. Because of that, the adapter needs to decode the request information into a consistent format. We try to keep keys and paths intact, but the structure results from our decoding. All steps used in the decoding for this adapter are documented here.

Description | Pseudo code

1. Parse the request body as JSON. Store that in the variable `b`.
2. Parse the property at JSONPath `batch` in the variable `b` as JSON. Store that in the variable `batch`.
3. Get the property at JSONPath `relative_url` for every element in the variable `batch`. Store that in the variable `relativeUrls`.
4. Parse every element in the variable `relativeUrls` as a query string. Store that in the result for the request body at `batch`.
5. Get the property at JSONPath `batch_app_id` in the variable `b`. Store that in the result for the request body at `batch_app_id`.

https://trackers.tweasel.org/t/facebook/graph/

5. Get the property at JSONPath `batch_app_id` in the variable `b`. Store that in the result for the request body at `batch_app_id`.

Observed data transmissions

This is data that we observed being transmitted by this tracker. *Not every request contains all of this data.* The context of the data describes where we found the data in the request, the path describes the location of the data in the decoded request. The examples are a selection of observed values.

Property	Context	Path	Examples of observed values
Device advertising ID	body	`batch.*.advertiser_id`	`00000000-0000-0000-0000-000000000000`
OS name	body	`batch.*.platform`	`ios`
	body	`batch.*.sdk`	`ios`
OS version	body	`batch.*.os_version`	`14.8` `14.8.0`

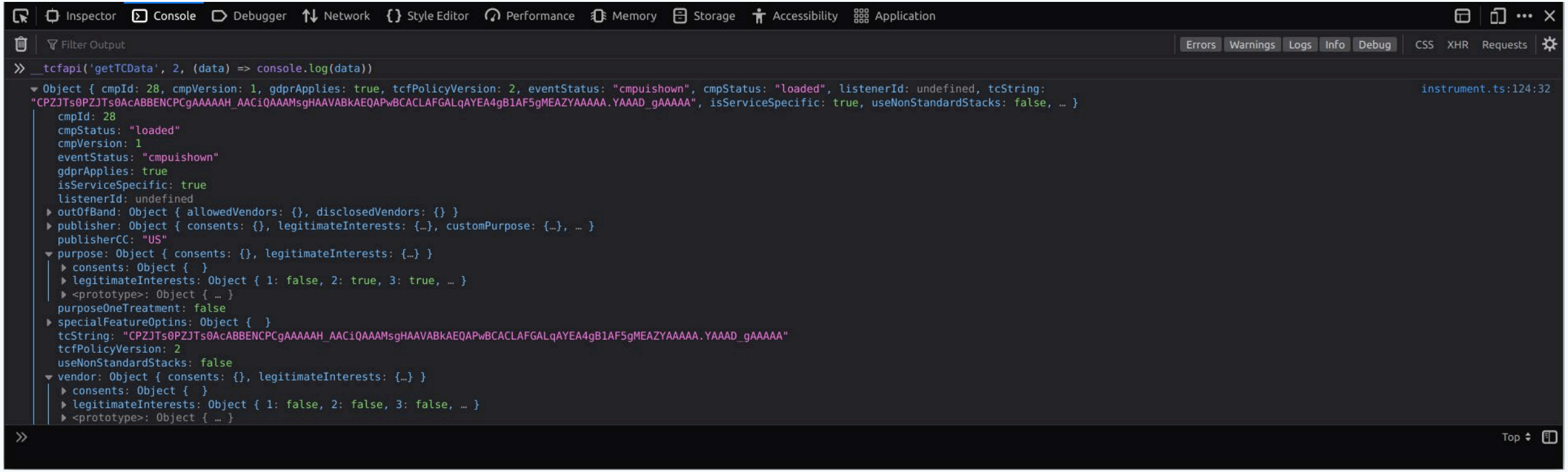
Other identifiers	body	`batch.*.anon_id`	`XZA1964B79-5236-4744-B9B0-F910F28BEBCD`
			`XZABCB7B81-9419-4A93-9DE4-ED3EC44F81E4`
			`XZ7587BD00-BD1B-4864-8F14-C1D90D2DB000`
			`XZ5D90BBDC-24B4-4BAC-B23D-D7177749FC4F`
			`XZ21C85A45-8805-4857-A30A-AEE04A9B044F`

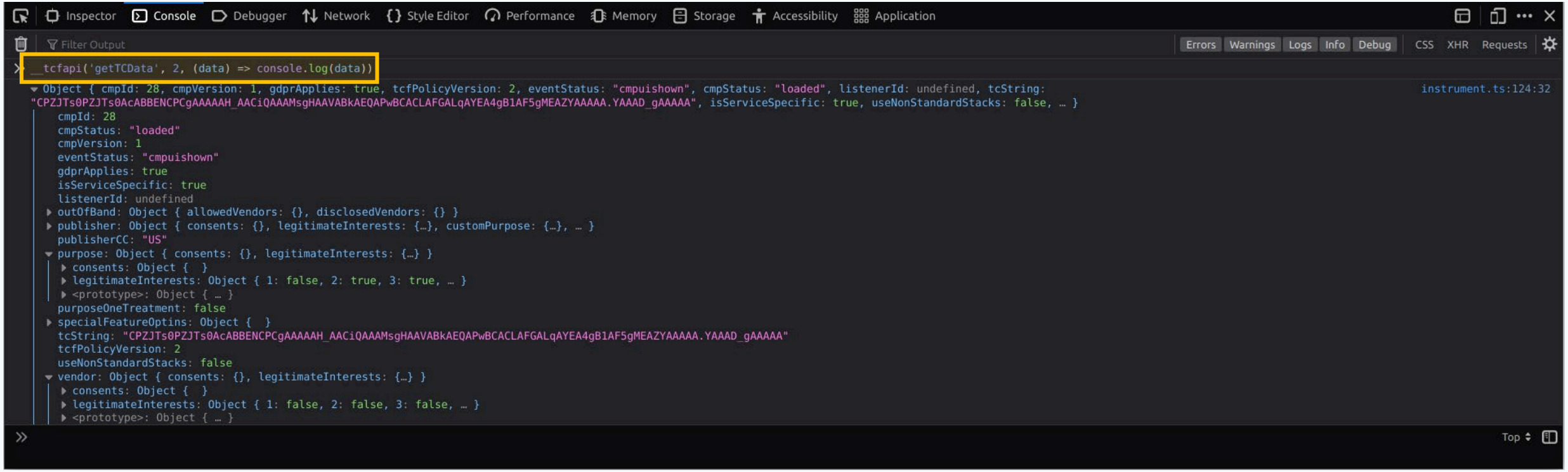
Tracker SDK version	body	`batch.*.sdk_version`	`11.1.0`
			`12.3.2`
			`12.1.0`
			`8.2.0`
			`8.0.0`

https://trackers.tweasel.org/t/facebook/graph/

Analysing consent dialogs

How can we automatically detect the presence of a consent dialog in an app and whether it uses dark patterns?


Inspector
Console
Debugger
Network
Style Editor
Performance
Memory
Storage
Accessibility
Application
Filter Output
Errors
Warnings
Logs
Info
Debug
CSS
XHR
Requests
__tcfapi('getTCData', 2, (data) => console.log(data))
Object { cmpId: 28, cmpVersion: 1, gdprApplies: true, tcfPolicyVersion: 2, eventStatus: "cmpuishown", cmpStatus: "loaded", listenerId: undefined, tcString: "CPZJTs0PZJTs0AcABBENCPCgAAAAAH_AACiQAAAMsgHAAVABkAEQAPwBCACLAFGALqAYEA4gB1AF5gMEAZYAAAAA.YAAAD_gAAAAA", isServiceSpecific: true, useNonStandardStacks: false, … }
instrument.ts:124:32
cmpId: 28
cmpStatus: "loaded"
cmpVersion: 1
eventStatus: "cmpuishown"
gdprApplies: true
isServiceSpecific: true
listenerId: undefined
outOfBand: Object { allowedVendors: {}, disclosedVendors: {} }
publisher: Object { consents: {}, legitimateInterests: {…}, customPurpose: {…}, … }
publisherCC: "US"
purpose: Object { consents: {}, legitimateInterests: {…} }
consents: Object { }
legitimateInterests: Object { 1: false, 2: true, 3: true, … }
<prototype>: Object { … }
purposeOneTreatment: false
specialFeatureOptins: Object { }
tcString: "CPZJTs0PZJTs0AcABBENCPCgAAAAAH_AACiQAAAMsgHAAVABkAEQAPwBCACLAFGALqAYEA4gB1AF5gMEAZYAAAAA.YAAAD_gAAAAA"
tcfPolicyVersion: 2
useNonStandardStacks: false
vendor: Object { consents: {}, legitimateInterests: {…} }
consents: Object { }
legitimateInterests: Object { 1: false, 2: false, 3: false, … }
<prototype>: Object { … }
Top


Inspector
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Object { cmpId: 28, cmpVersion: 1, gdprApplies: true, tcfPolicyVersion: 2, eventStatus: "cmpuishown", cmpStatus: "loaded", listenerId: undefined, tcString:
"CPZJTs0PZJTs0AcABBENCPCgAAAAAH_AACiQAAAMsgHAAVABkAEQAPwBCACLAFGALqAYEA4gB1AF5gMEAZYAAAAA.YAAAD_gAAAAA", isServiceSpecific: true, useNonStandardStacks: false, … }
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vendor: Object { consents: {}, legitimateInterests: {…} }
consents: Object { }
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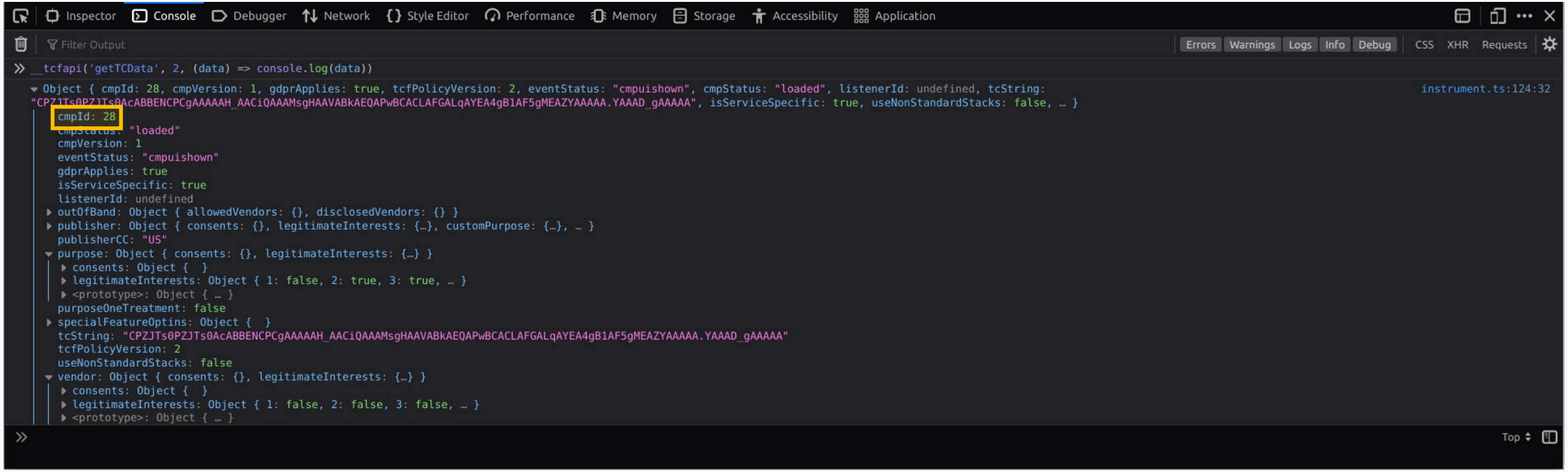
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vendor: Object { consents: {}, legitimateInterests: {…} }
consents: Object { }
legitimateInterests: Object { 1: false, 2: false, 3: false, … }
<prototype>: Object { … }
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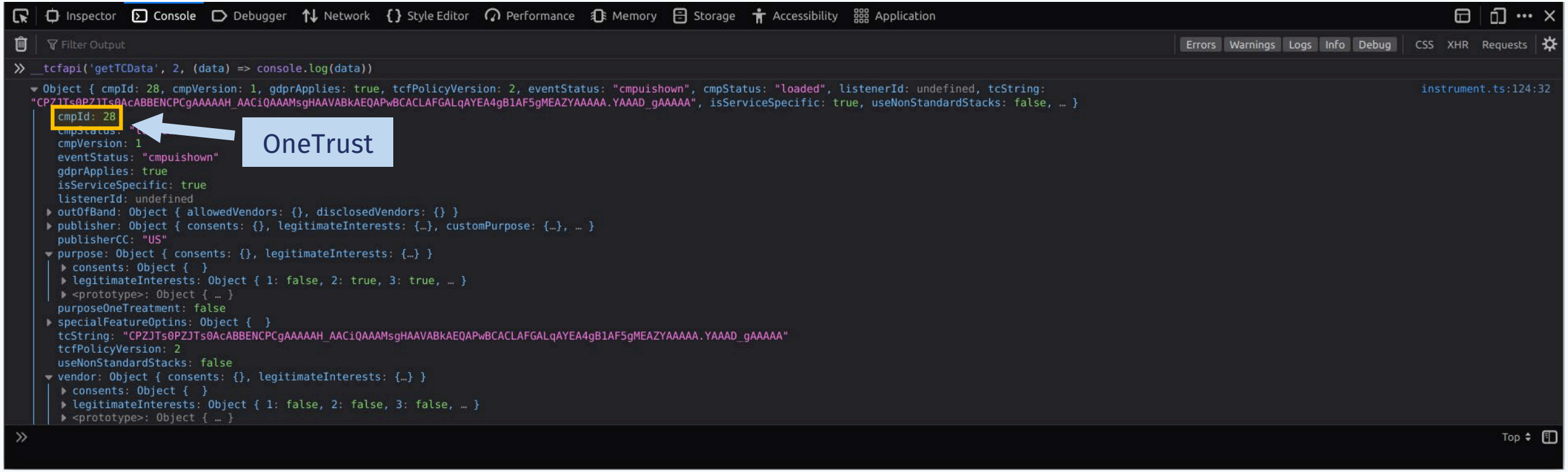
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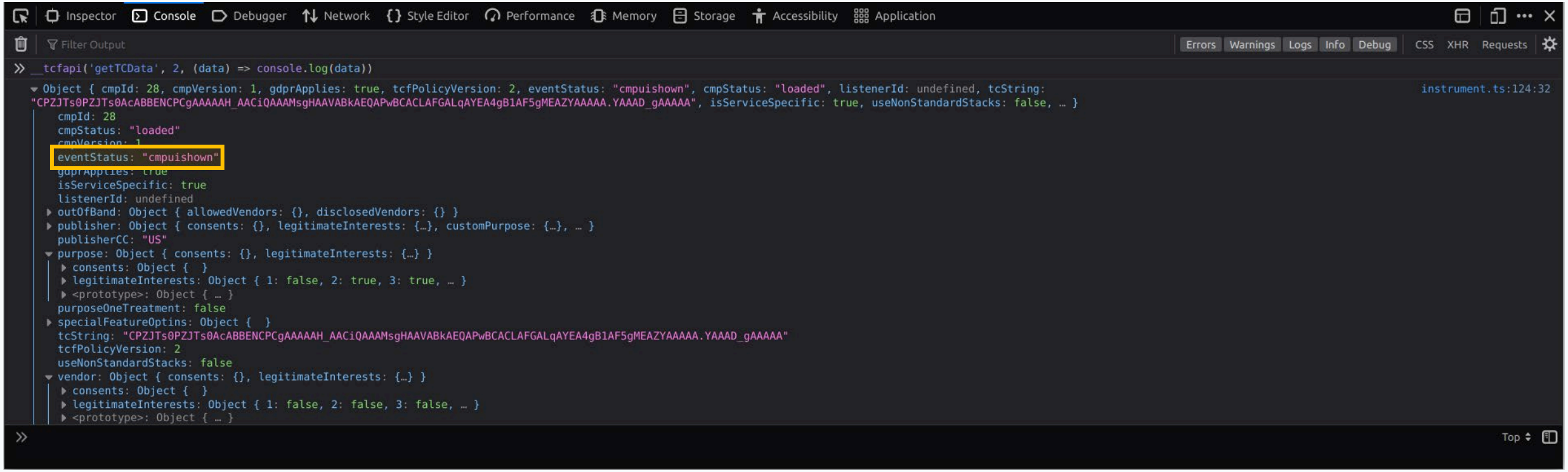
OneTrust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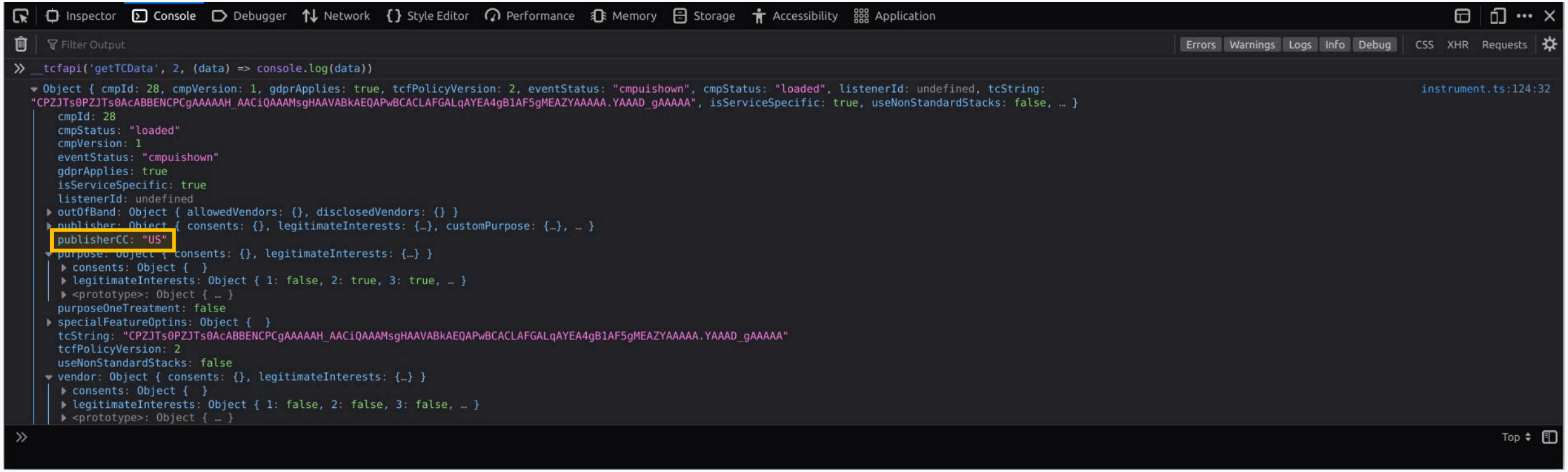
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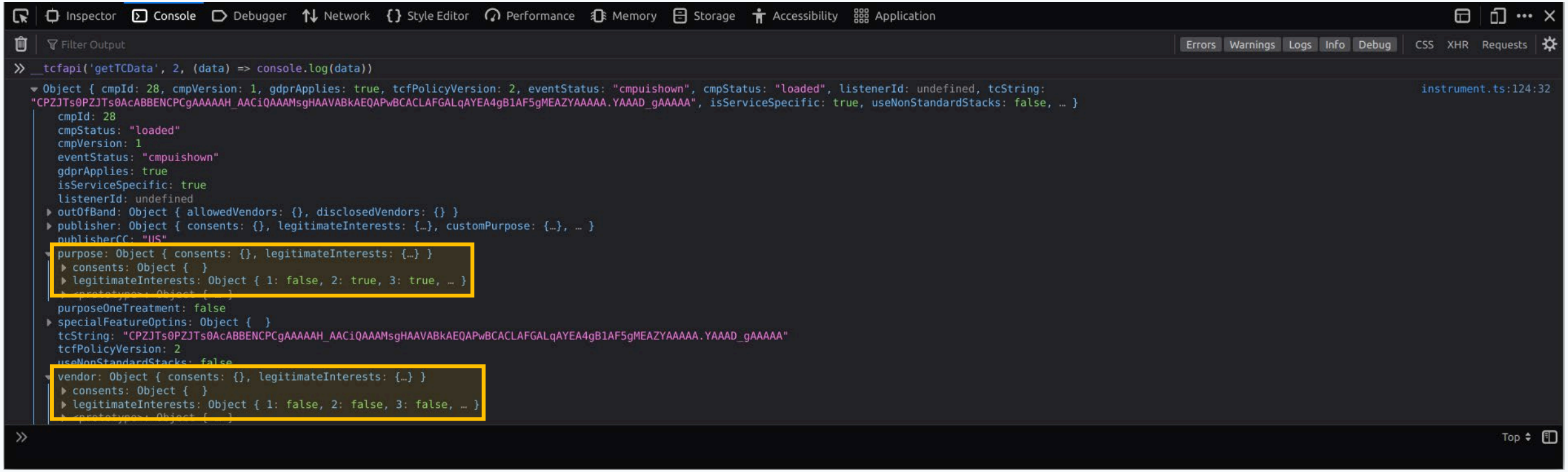
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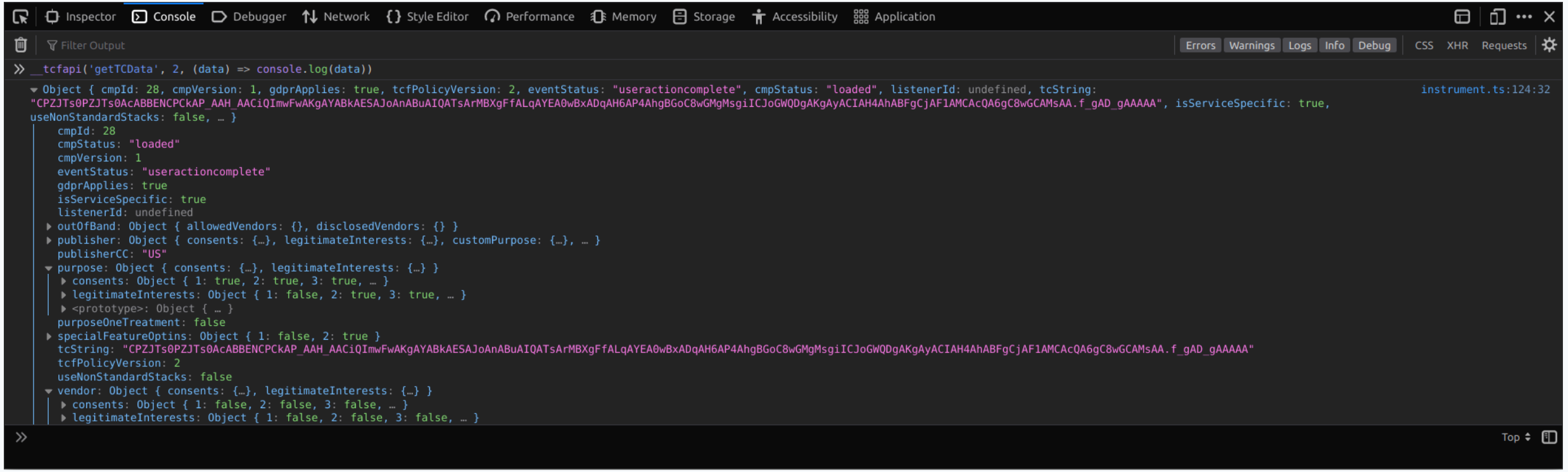
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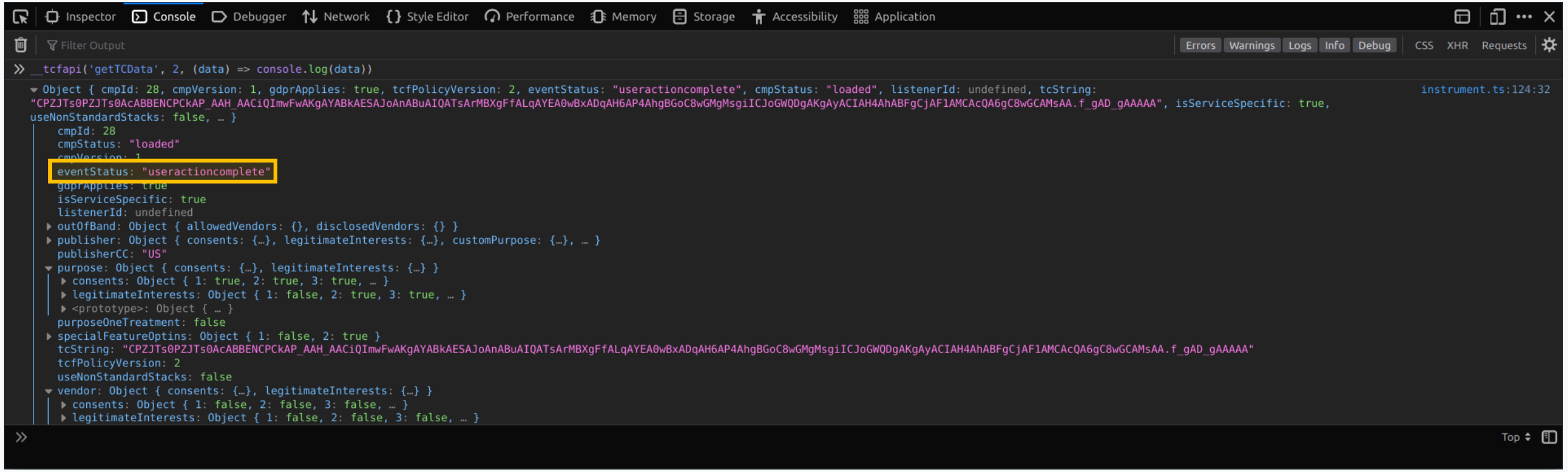
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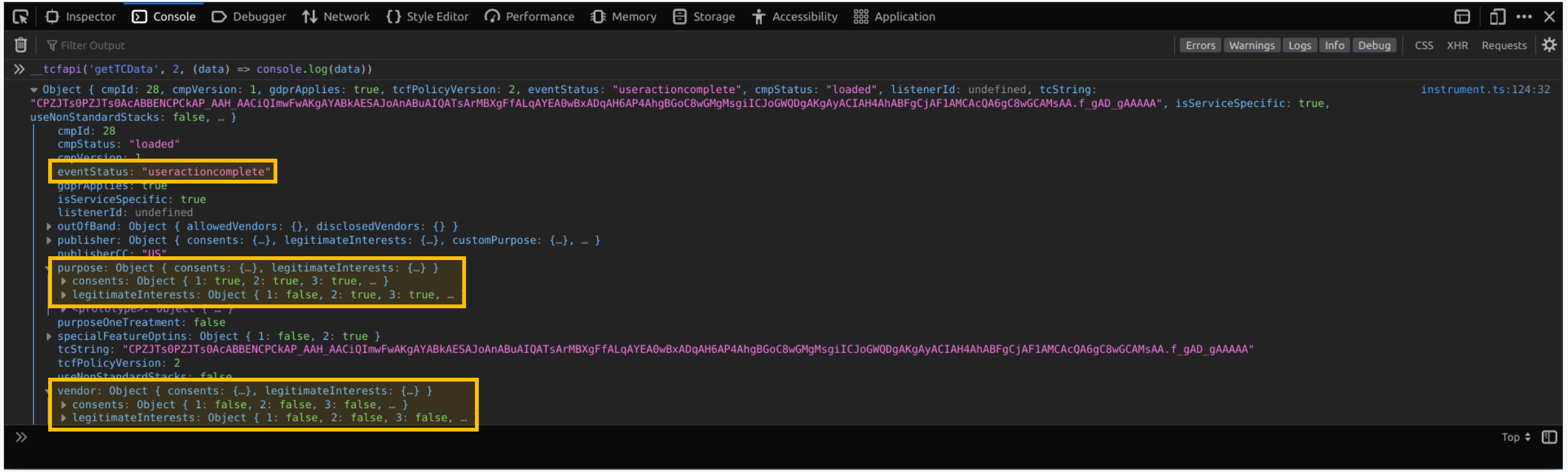
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- TCF standard is available for apps as well.
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- Idea: Adapters for specific CMPs?
  - Rough pre-study about usage of known CMPs: 2.8 % on iOS, 7.15 % on Android (upper bound).

What now?

- Use text-based recognition to find commonly used consent dialog elements.

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- For that, we have regexes to detect common phrases, e.g.:

```
/have read( and understood)? [^.]{3,35} (privacy|
  cookie|data protection|GDPR)(policy|notice|
  information|statement)/
```

- Additionally, false-positive mitigations, e.g. keyword score to weed out terms of services notices.

Future plans

- We plan to:
  - Automatically assess the legality of data transmissions.
  - Inform users about illegal transmissions.
  - Generate full complaint texts and evidence from the our app analyses.
  - Allow users to easily apply our complaints to their own case and send them themselves.

Stay in touch

- We are on Mastodon: @datarequestsORG@mastodon.social, @dev_at_datarequestsORG@chaos.social
- Blog for longer posts (RSS): https://www.datarequests.org/blog
- Any questions left? Contact us! kontakt@datenanfragen.de
- Do you want to help? Contribute to our GitHub projects!

That's it.

Slides are available online:

https://www.datarequests.org/verein/event/edpb-expert-talk-2023