AppProfiler: A Flexible Method of Exposing Privacy-Related Behavior in Android Applications to End Users

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The Problem

- Smartphones have lots of personal data, lots of apps: privacy concerns.
- Hard to make informed decisions about what applications to install.
  - Filtering malware not enough.
  - Privacy-intrusive applications may be acceptable for some but not others.
- Goal: Let users know what their apps do, in terms of privacy-sensitive behavior.

What about existing approaches?

- Permissions are supposed to tell users how their applications behave
  - May be vague or even incorrect
  - Many so prevalent that users are likely to ignore them
  - Inflexible to modification
- Many proposals to improve the permission system
  - We focus on immediate solutions
- Many proposals protect against smartphone-specific attacks or malware
  - We focus on legitimate apps

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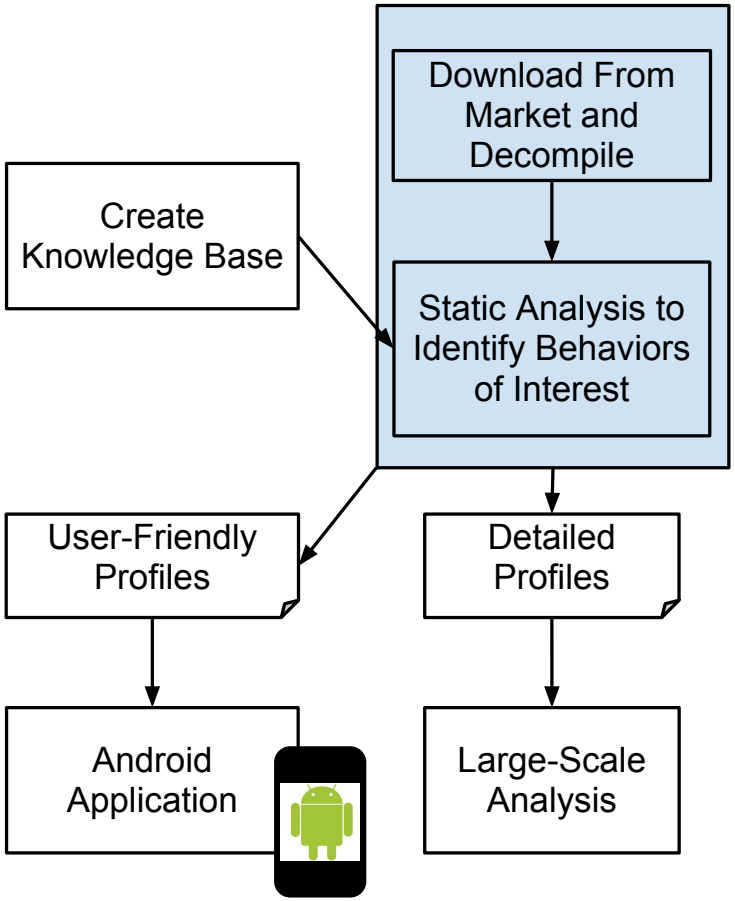

- Automatically create profiles of application behavior offline.
  - Knowledge base mapping API calls to behaviors of interest
  - Use static analysis to find these behaviors
- Provide profiles to end users
- Also useful for more broadly understanding app behavior
- Flexible: Rules/profiles can easily be adapted

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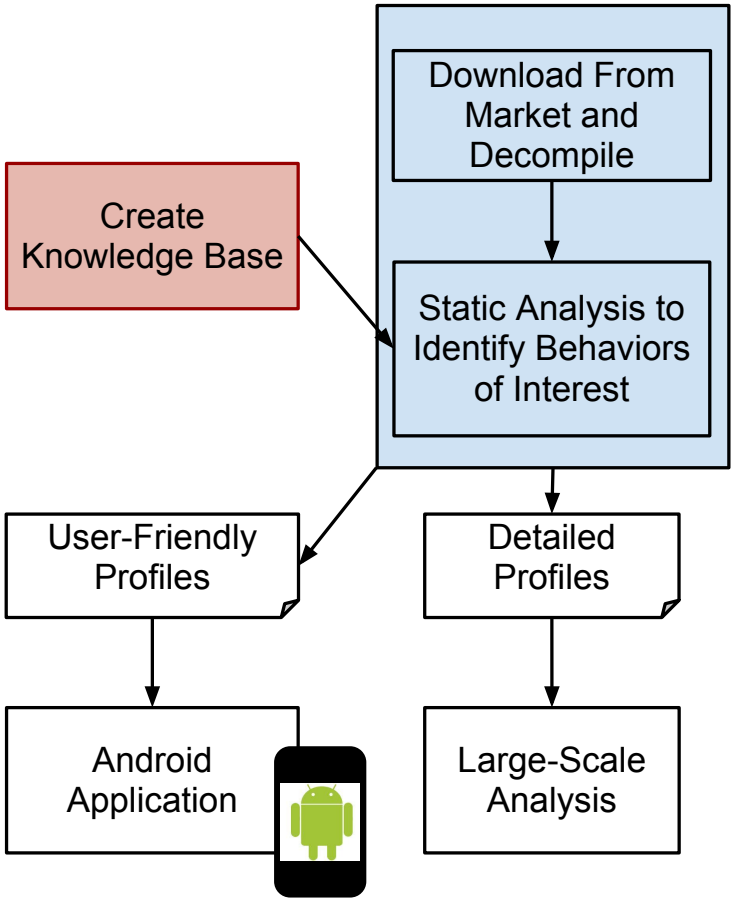

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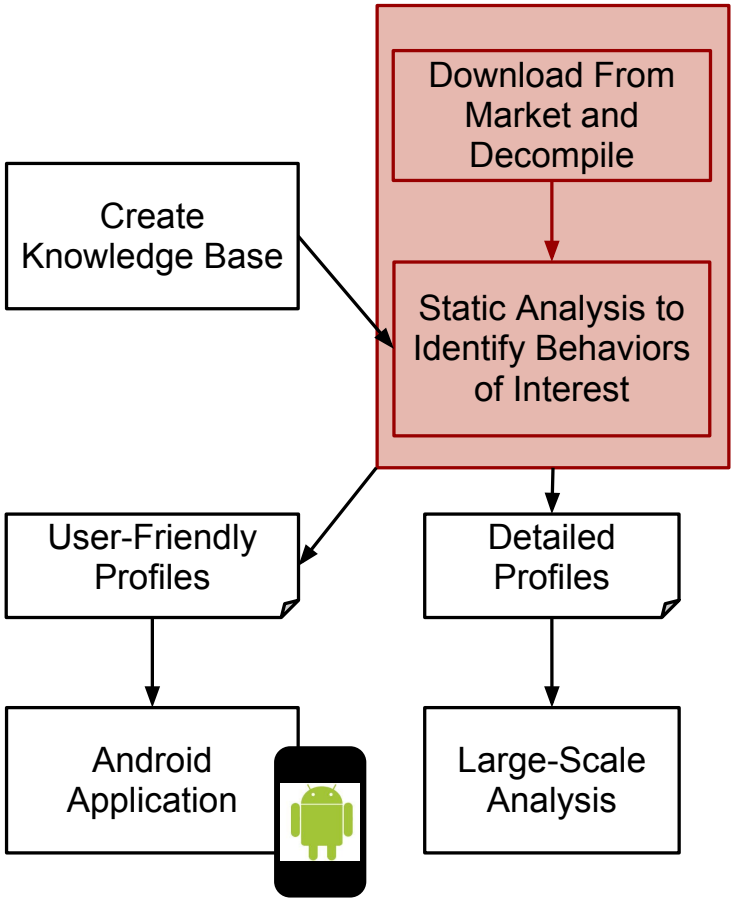

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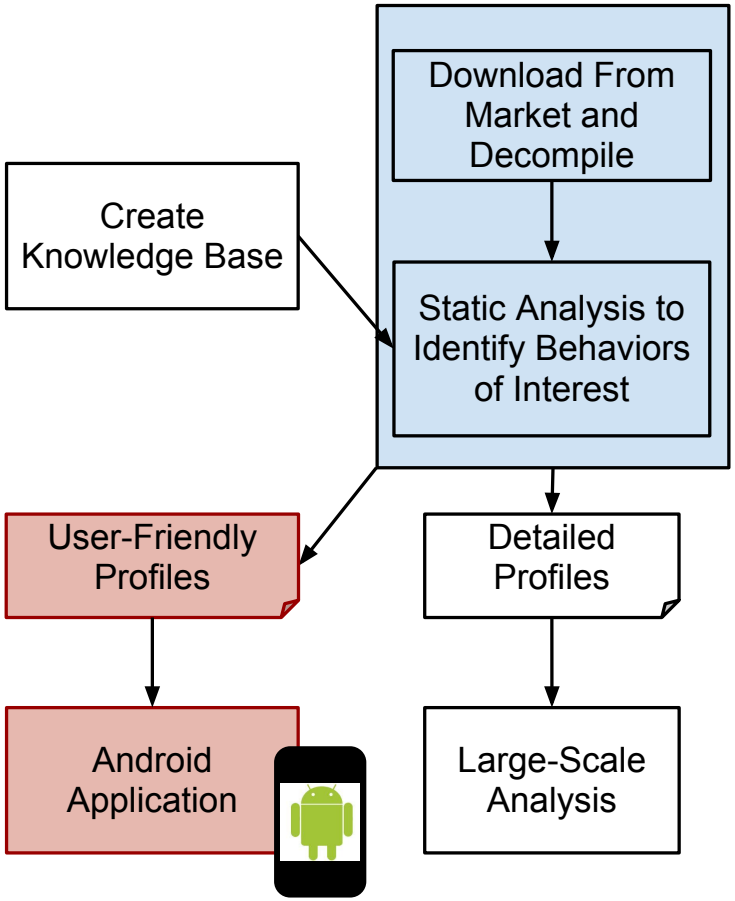

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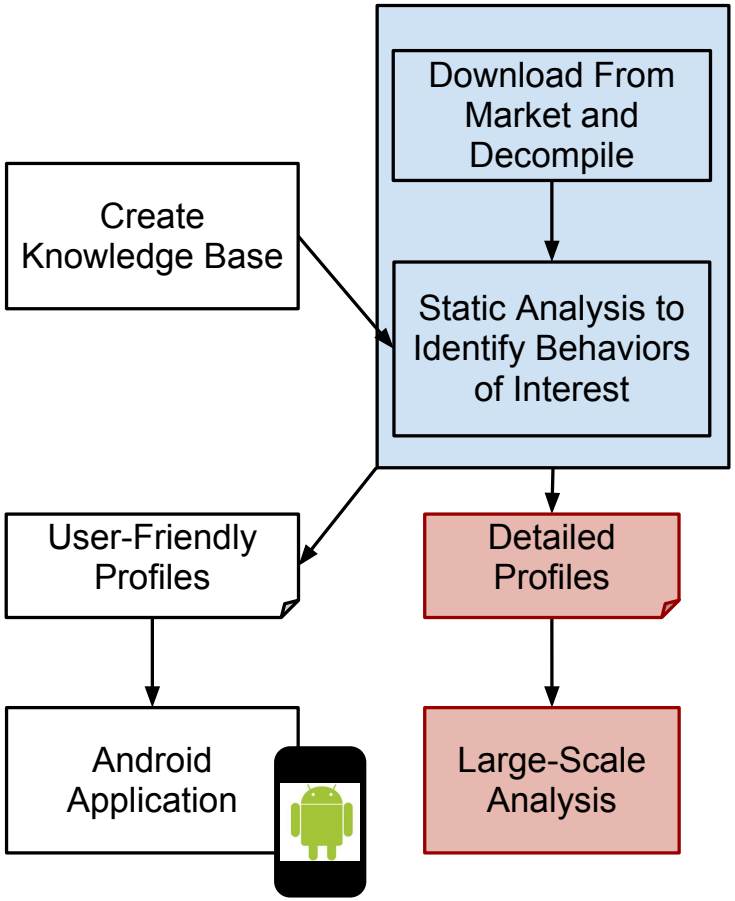

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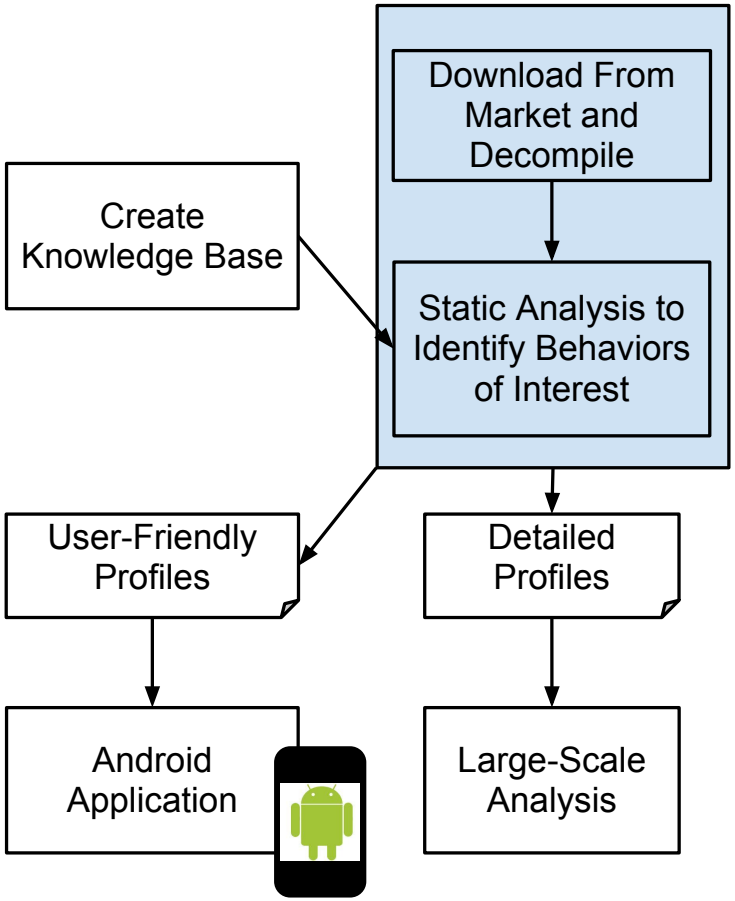

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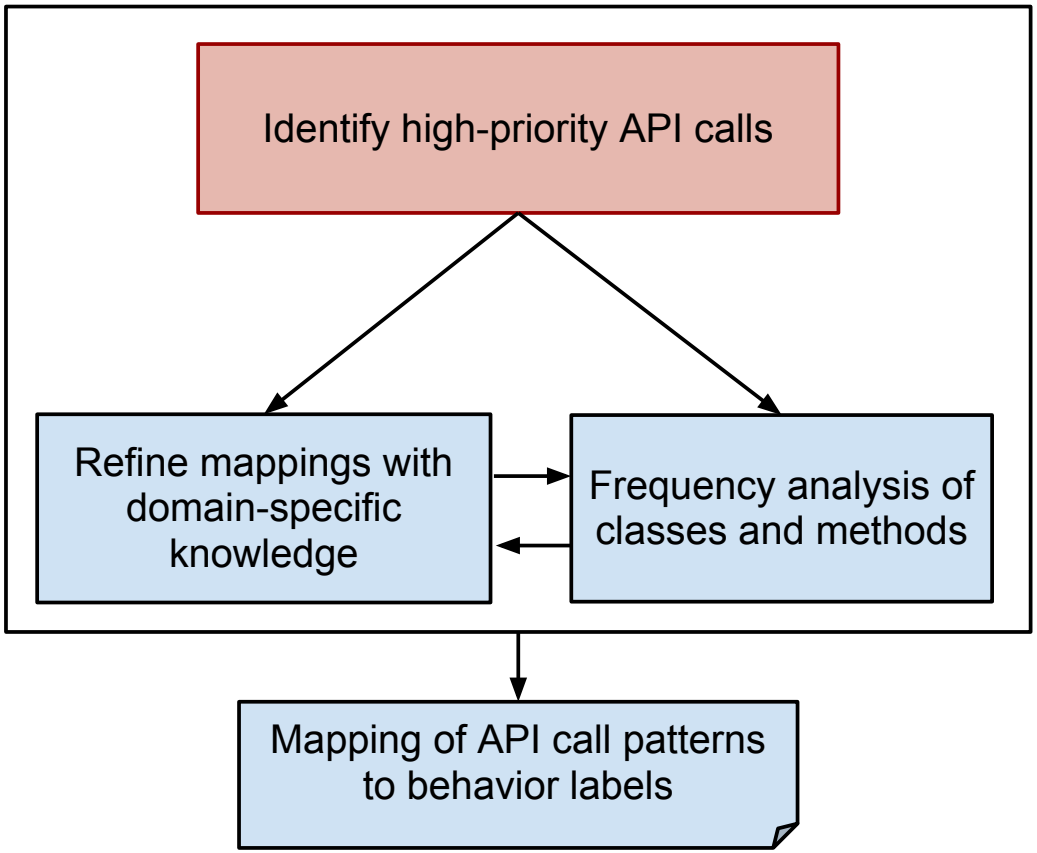
Basic Assumptions and Limitations

- We do not attempt to detect malware or applications that otherwise subvert the Android framework API
- We do not currently address native code
- We supplement (instead of replacing) the permission system
- Our target audience is privacy-concerned users who are concerned about how apps behave

Step 1: Build the Knowledge Base



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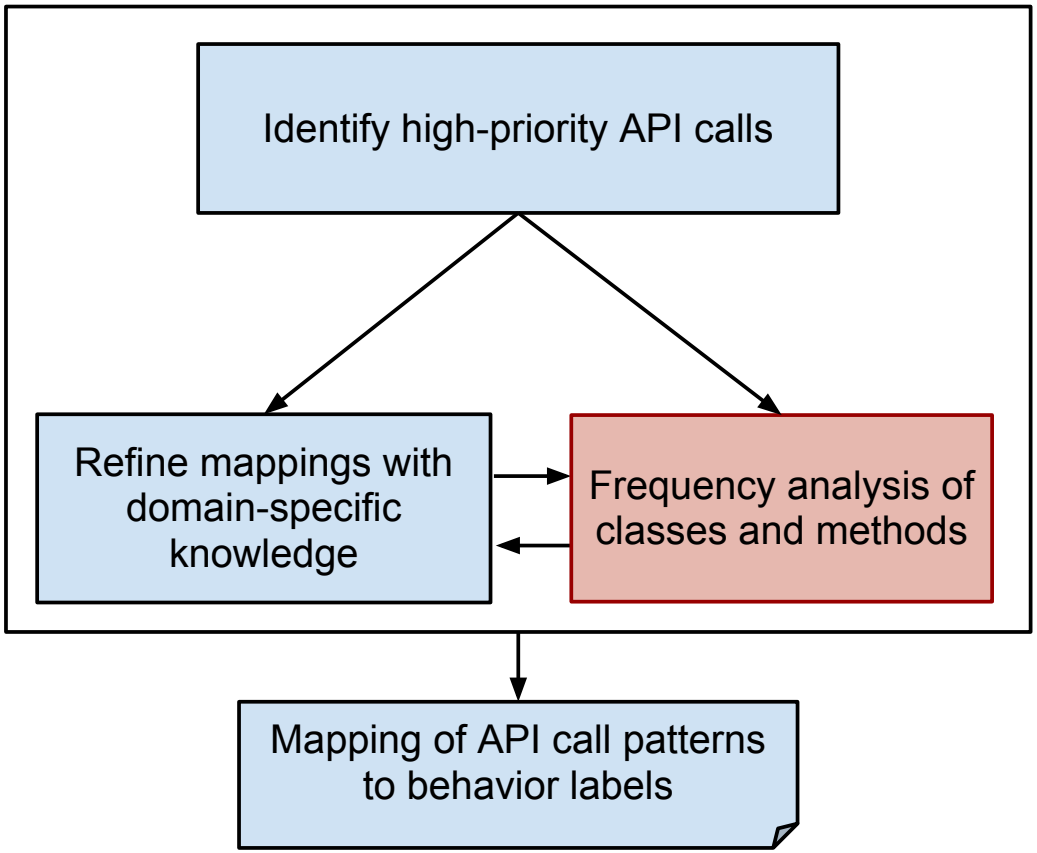

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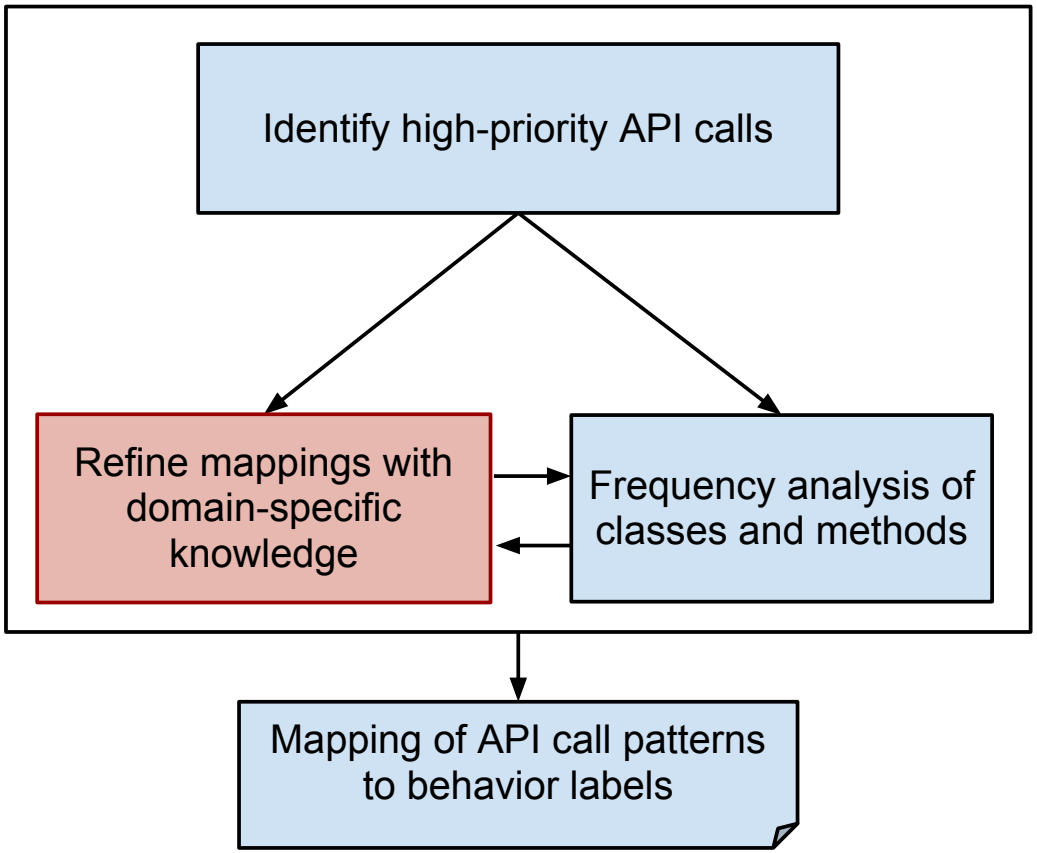

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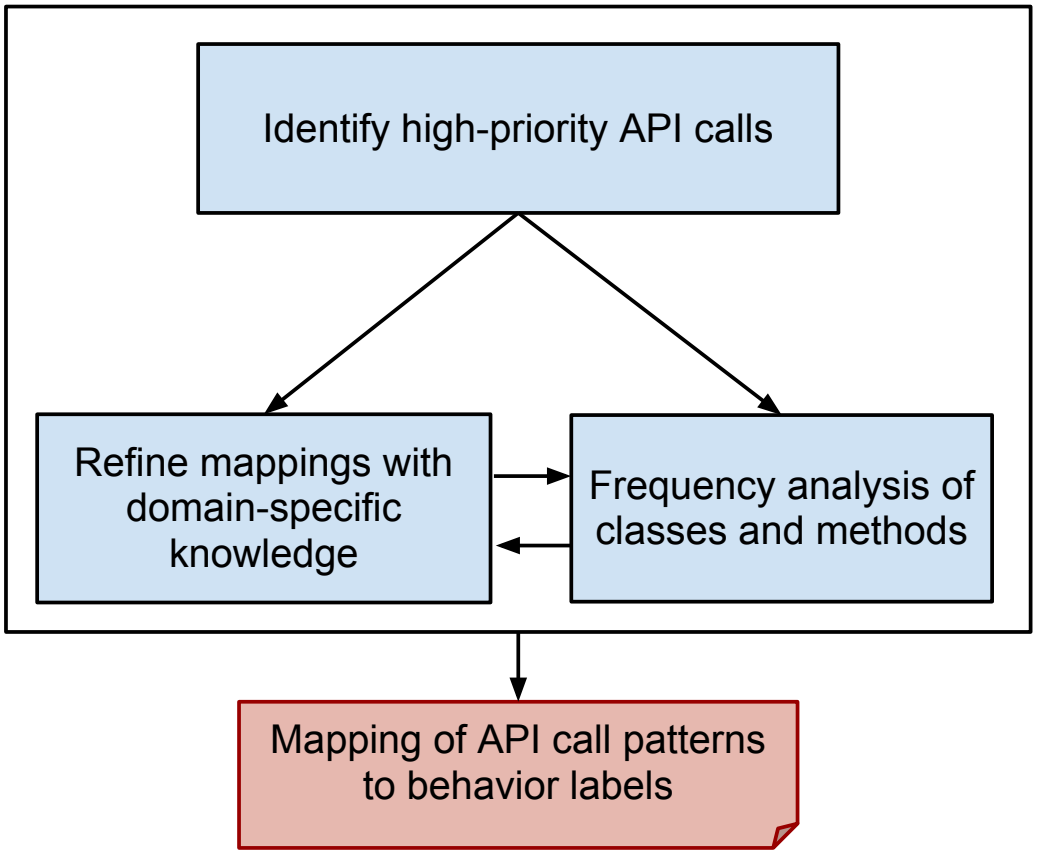


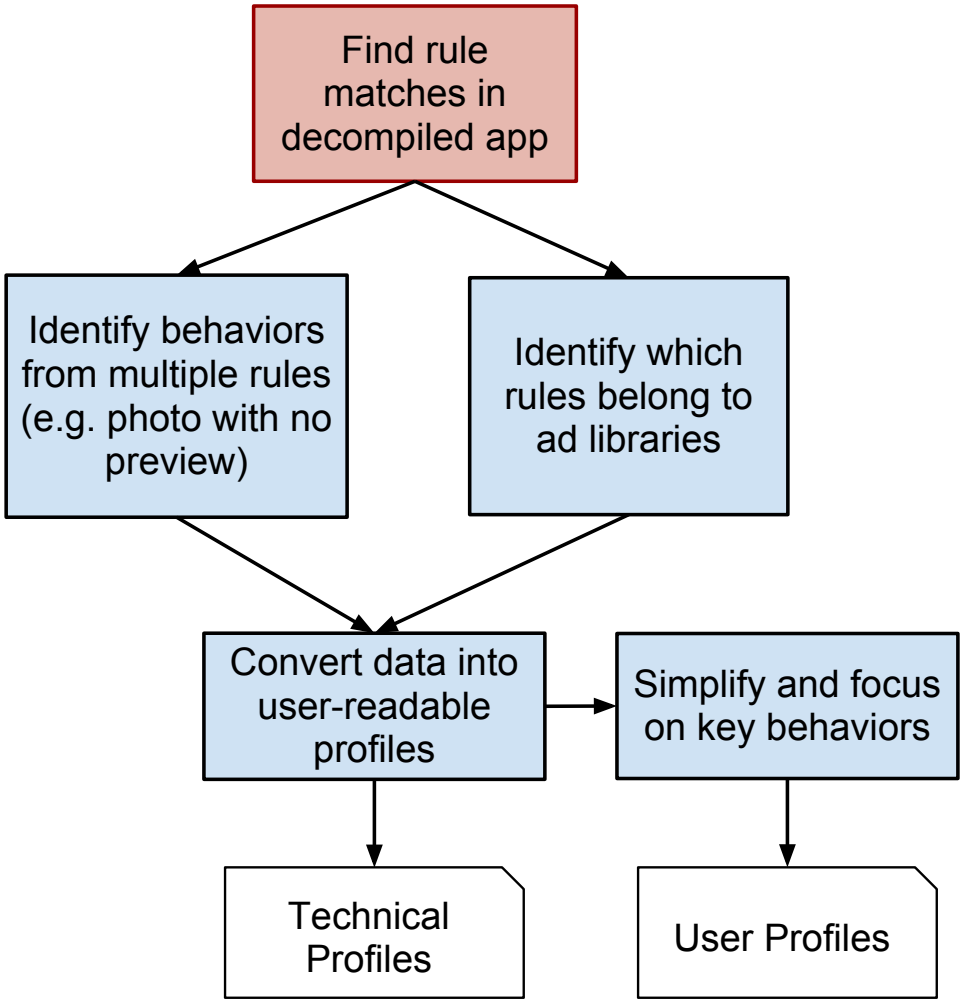
Example Knowledge Base Entry

```
Category:
Location - Type
Subcategory: Regional data - State

FunctionCall call:
call.function.enclosingClass.name startsWith
"android.location.Address"
and call.function.name == "getAdminArea"

FunctionCall call:
call.function.enclosingClass.name startsWith
"android.location.Address"
and call.function.name == "getSubAdminArea"
```

Step 2: Apply to applications



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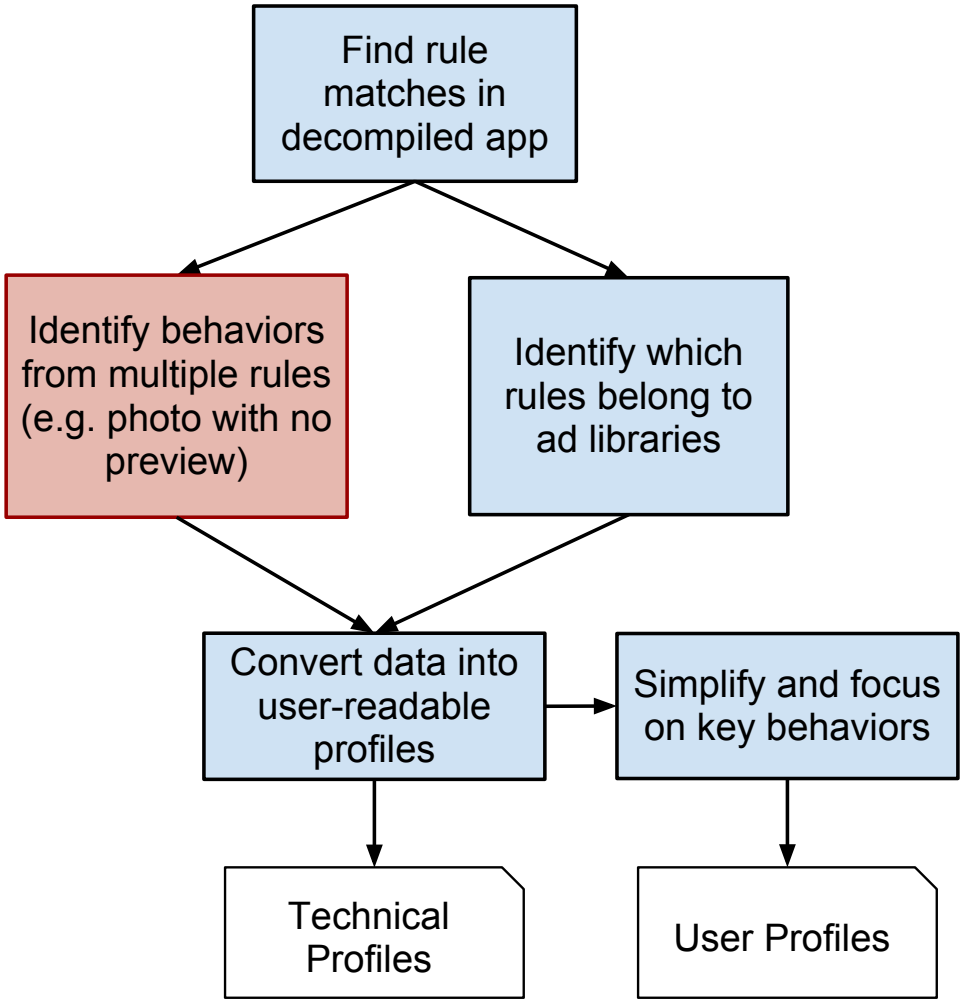

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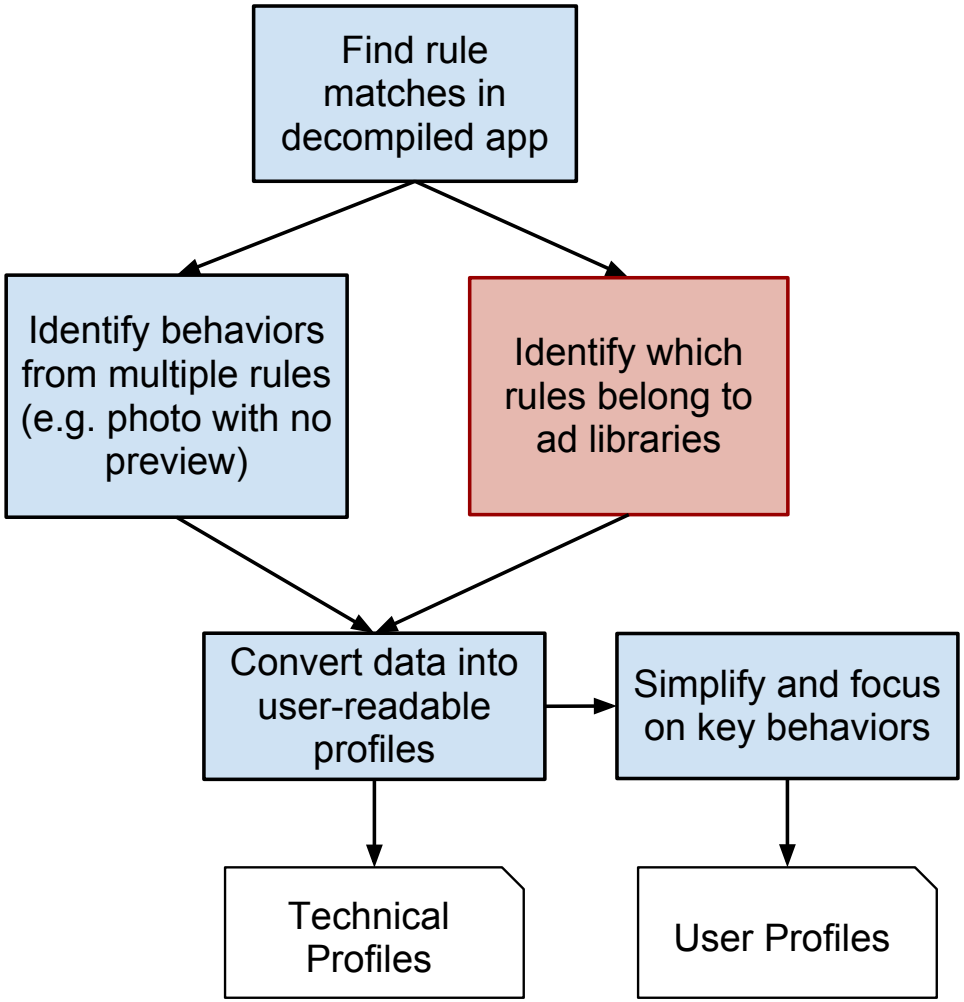

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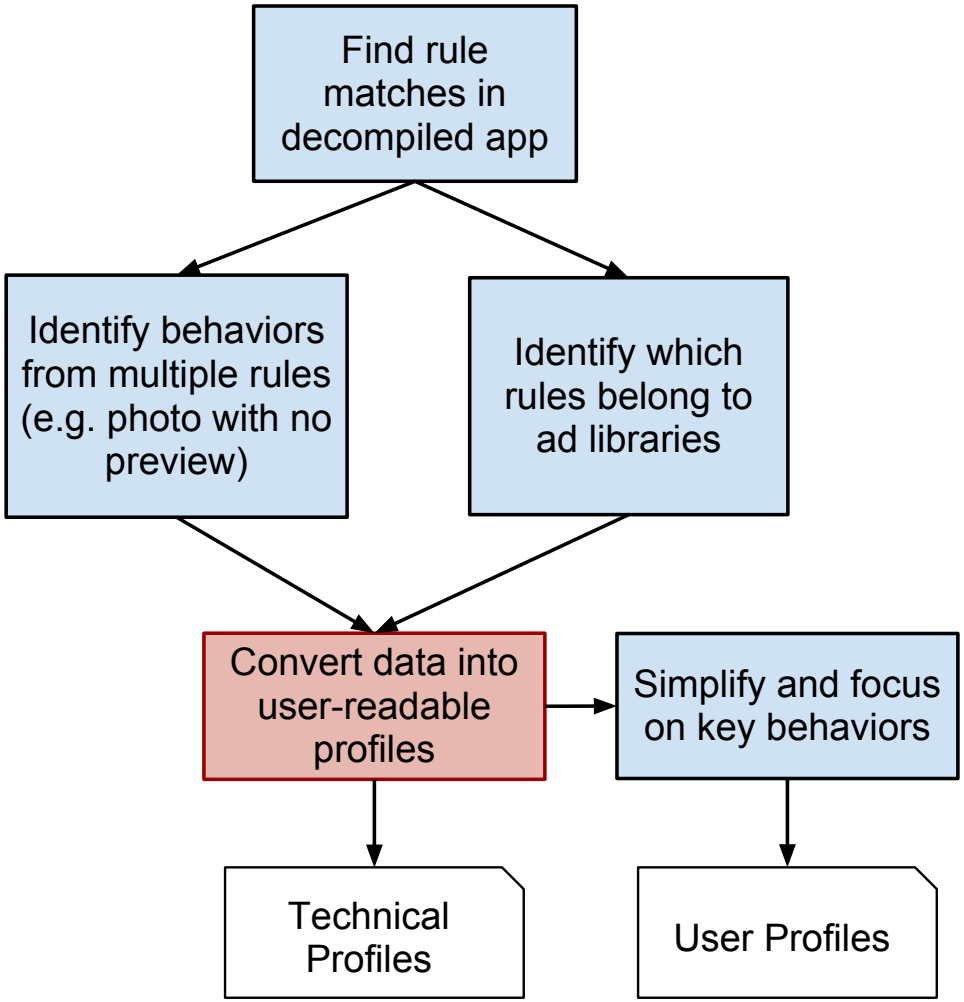

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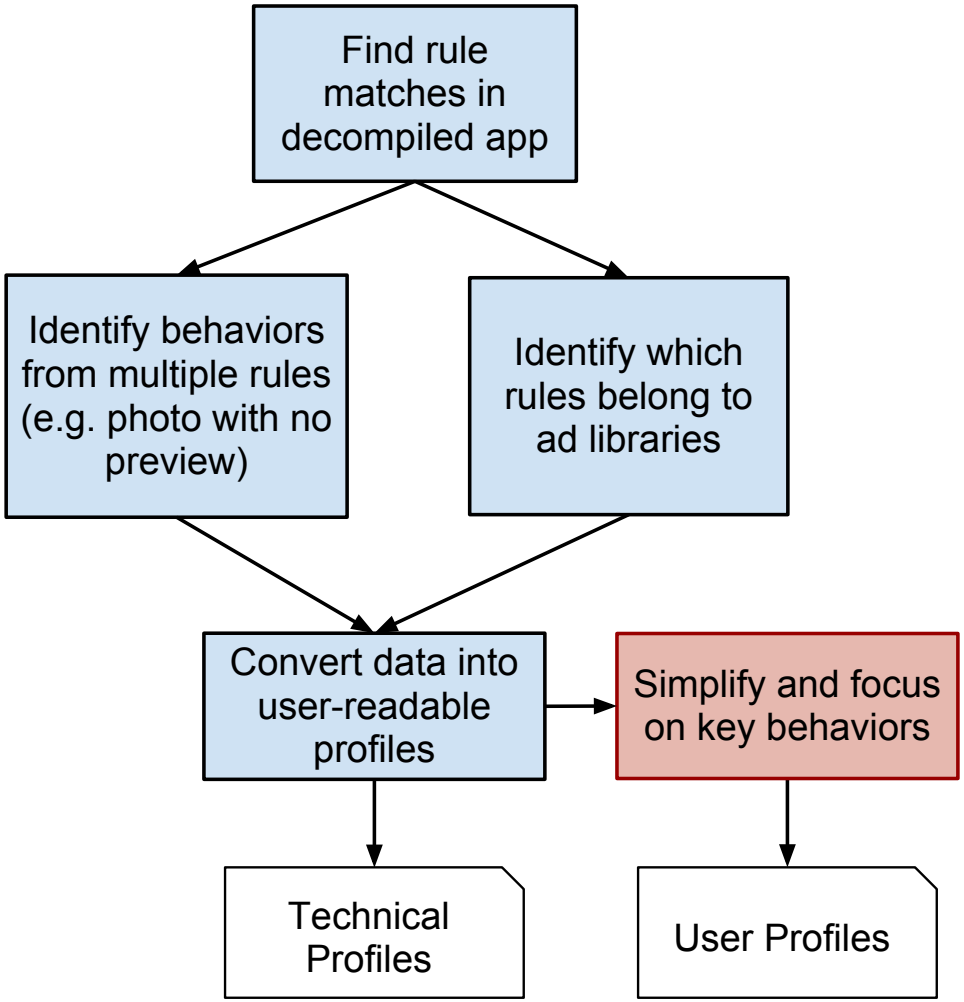


Example Profile Excerpt

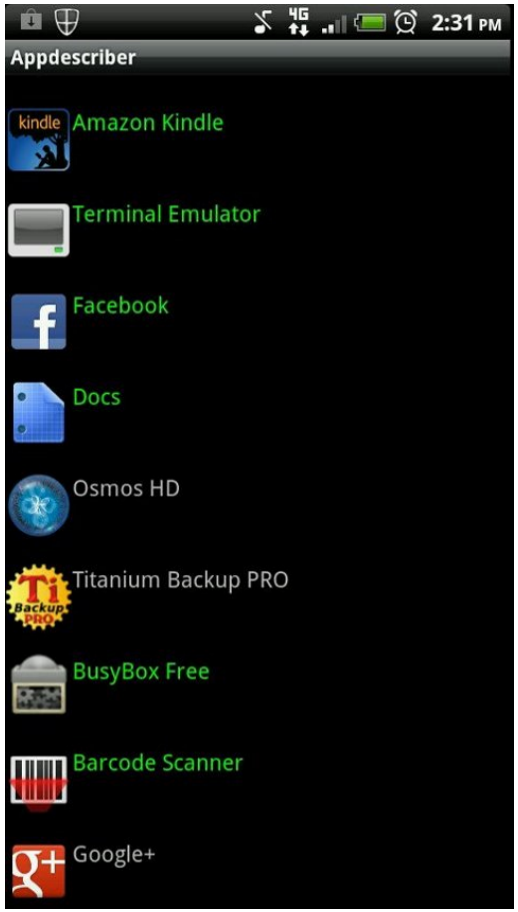
Technical Profiles

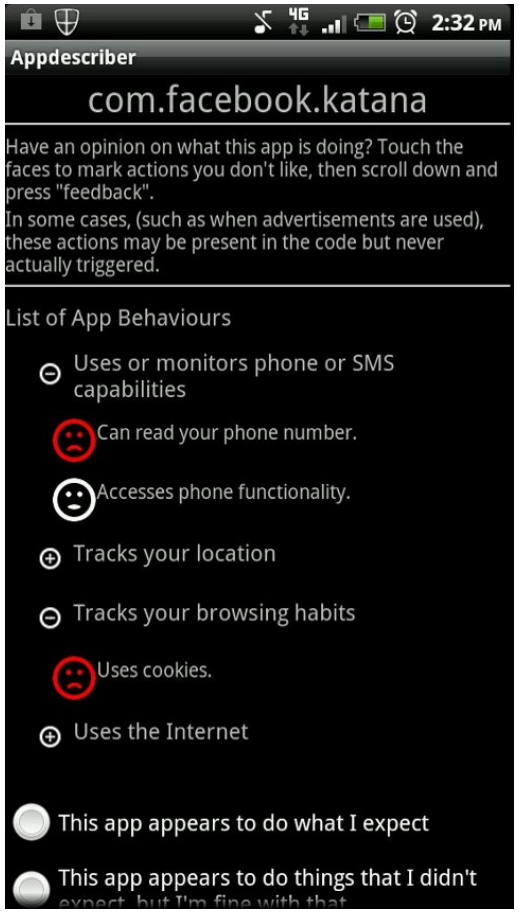
- Use GPS or network
- latitude/longitude (broadcast receiver)
- Updates every 1s or less (activity) (jumptap library)
- Proximity to location (activity, on click)

User-Friendly Profiles

- Gathers fairly precise location data (e.g. GPS)
- Uses more of your phone's resources than recommended to gather location data
- Concerned with your proximity to a given location

Step 3: Make available to users (+ request feedback)





We have about 50 000 profiles available!

What benefit do they provide over permissions?

Based off the feedback submitted:

- Provide *more specific* information that is relevant to users. Examples:
  - Cookies flagged as objectionable 23% of the time vs 6% for Internet use in general
- Behavior not covered by permissions can be objectionable
  - E.g. accelerometer (info about user movement patterns?)
- Users care about non-malicious but privacy-intrusive behavior
  - Users not that concerned about SMS messages
  - Users mostly concerned about behavior affecting privacy

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Case Study - Facebook

- Findings (manually confirmed):
  - Intrusive and frequent location data, phone number, info about the carrier
  - However, mostly occurs only in response to direct user input
  - Did *not* detect SMS-related behavior, even though it asks for related permission
- In short, permissions make it look worse than it really is!
- More detailed/more contextual information is important to really understand what is happening

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Accuracy

- False negatives often occurred due to decompilation errors; better tools will have a big impact
  - 15% in random applications
  - 10% in popular applications
- False positives occur primarily due to inactive third-party libraries
  - 16% rate in random applications
  - 23% in popular applications
- Although we do not attempt to address malware, detected 59% of malicious behaviors

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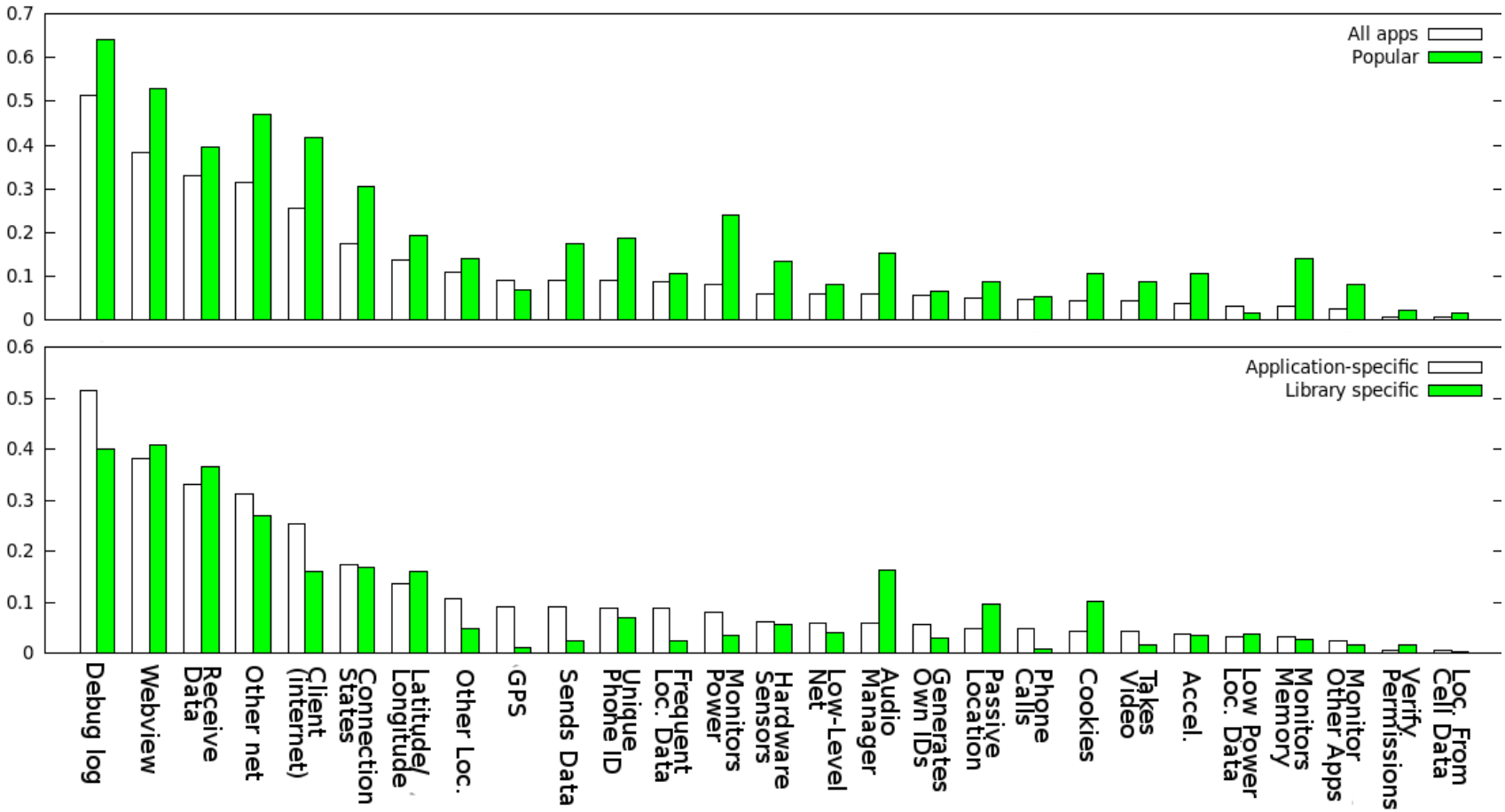

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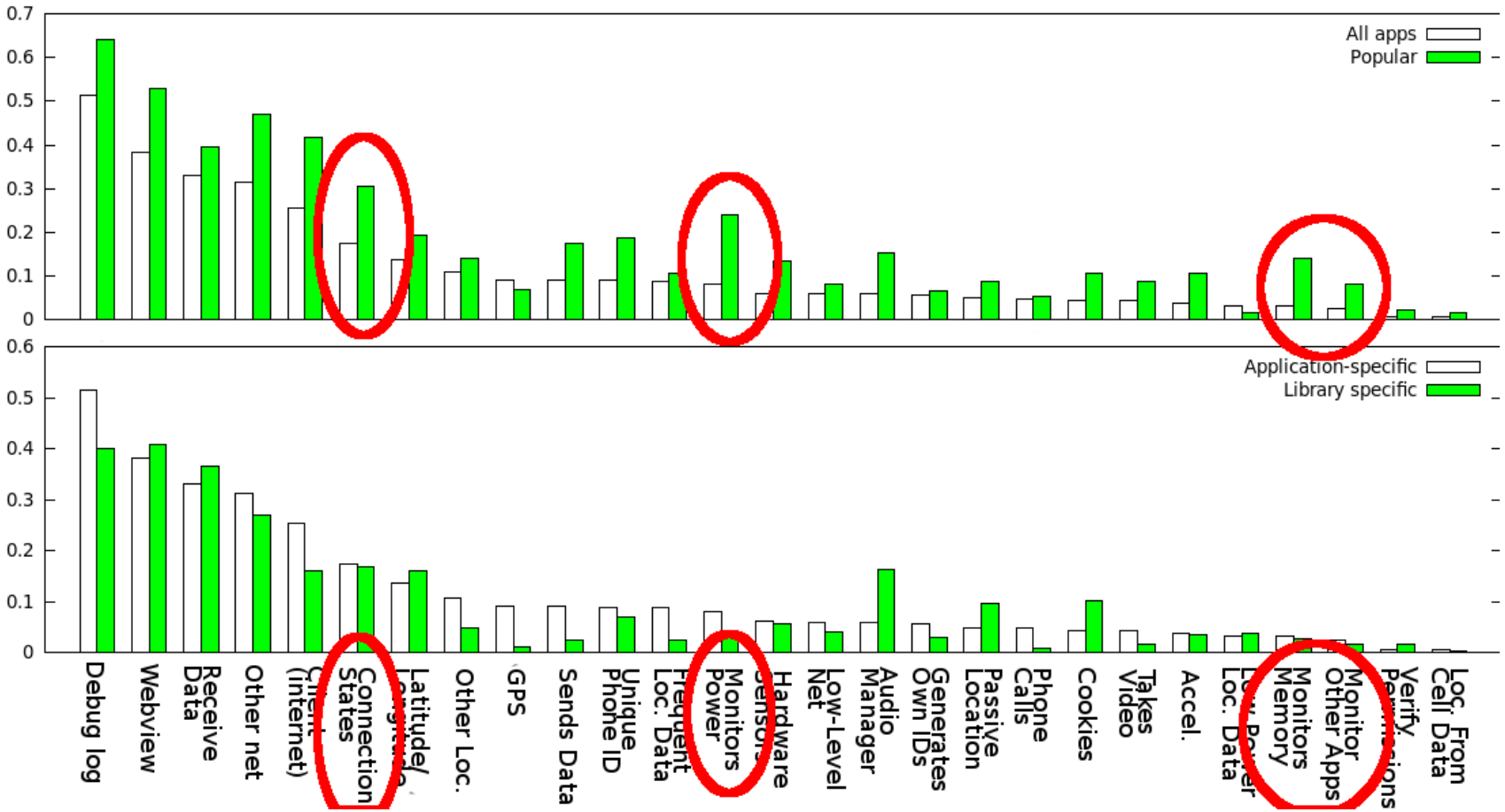

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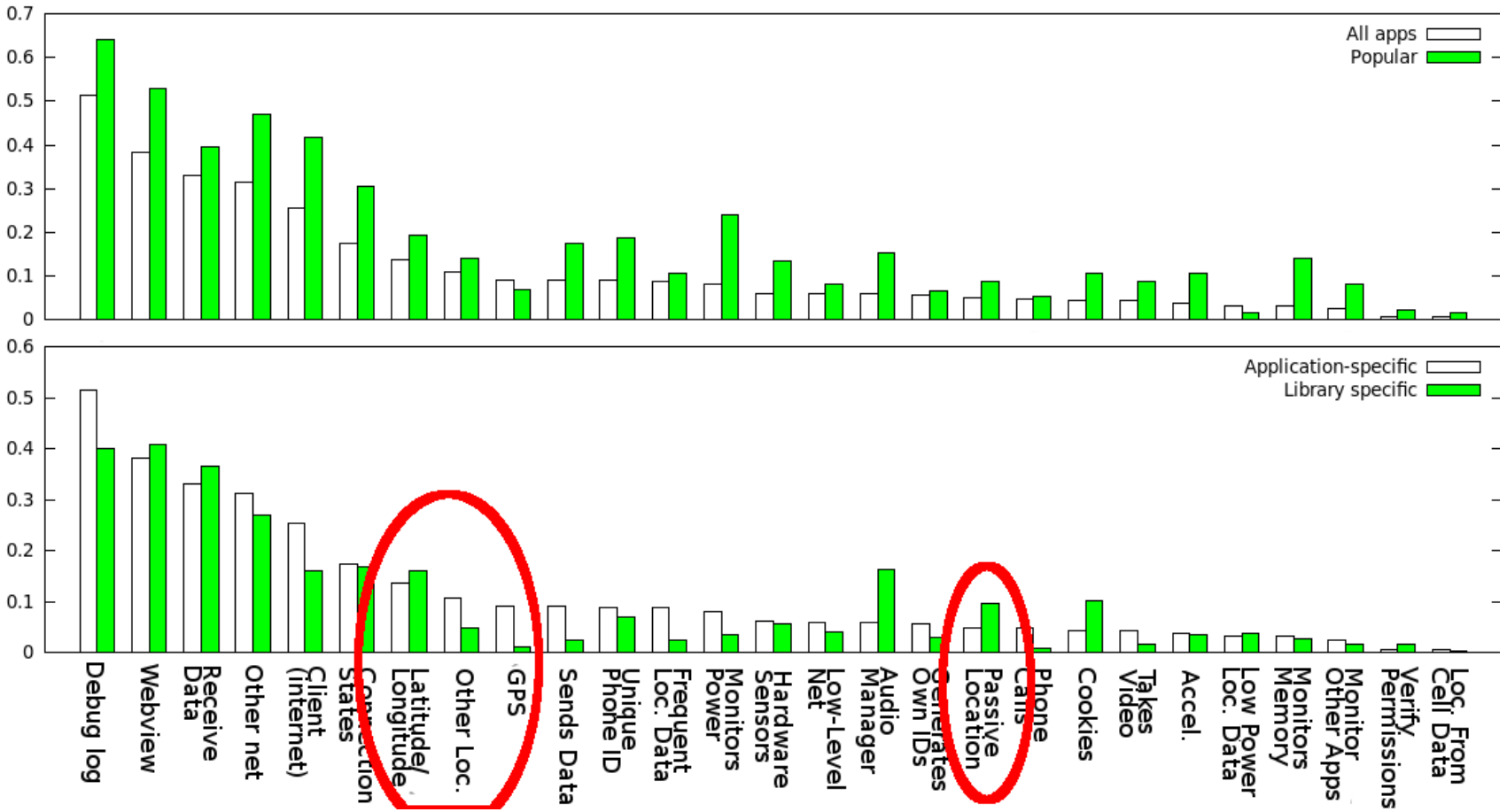

Summary

- Behavior profiles of applications can be automatically created using a knowledge base of API calls.
- These profiles allow users (as well as researchers) to better understand application behavior.
- For more information: http://appprofiles.eecs.umich.edu
- To download the app: https://play.google.com/store/apps/details?id=com.appdescriber

Questions?