

# eDoctor: Automatically Diagnosing Abnormal Battery Drain Issues on Smartphones

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## Abstract

The past few years have witnessed smartphones going from closed platforms containing only pre-installed applications to open platforms hosting a variety of third-party applications. Unfortunately, this change has also led to a rapid increase in Abnormal Battery Drain (ABD) problems caused by software defects, misconfiguration, or environmental changes. Such issues can drain a fully-charged battery within a couple of hours.

We present a practical tool called eDcotor to help average users troubleshoot ABD issues on smartphones. eDoctor leverages the concept of execution phase to capture an app’s energy consumption behavior, which is key to identify abnormal apps. Based on the diagnosis result, eDoctor suggests appropriate repair solutions to users.

## 1 Abnormal Battery Drain

ABD refers to abnormally fast draining of a smartphone’s battery that is not caused by normal usage. From a user’s point of view, the device previously had reasonable battery life under typical usage, but at some point the battery unexpectedly started to drain faster than usual. As a result, whereas users might comfortably and reliably use their phones for an entire day, with an ABD problem their batteries might unexpectedly exhaust within hours.

In our work [2], we randomly sampled 213 real world battery issues from popular Android forums. We found that 92% of them were ABD, while only 8% were due to normal, heavier usage. Many of these ABD incidents affected a significant number of users. For instance, a release of “Facebook for Android” app, with an estimated 12 million users at that time [1], had a bug that prevented the phone from entering sleep mode, thus draining the battery in as rapidly as 2.5 hours.

## 2 Execution Phases

To identify the problematic app(s) in an ABD issue, it is critical to differentiate abnormal from normal battery usage. A straightforward clue is to focus on the top battery consuming app reported by an energy profiler. Unfortunately, an app’s battery consumption rank can fluctuate

over time. Also, users need to judge whether the rank is due to heavier usage and, if not, what lead to the anomaly.

eDoctor takes a different approach based on a key observation: most ABD issues involve a new, energy-heavy *execution phase* emerging in a particular app. For example, in the Facebook bug, such new phase is characterized by the wakelock being held for a long time while other resources are used little in the meantime. This phase rarely exhibited before the buggy upgrade. What makes execution phase an useful indicator of anomaly for smartphone is that it corresponds to use scenarios, e.g., *composing*, *sending* and *receiving* in an email app, which has limited variety for many smartphone apps. In our study [2], we found majority of the monitored apps have fewer than 4 phases.

We explored two schemes of execution phases, namely *Resource Type Vector* and *Resource Usage Vector*. The former assumes that different phases use different resources, while the latter also considers the amount of resource usage. These vectors are then clustered to build phase table for abnormal phase detection. Together with recent user events, such as a configuration change, eDoctor can identify both the culprit app and triggering event.

## 3 Evaluation

To evaluate eDoctor’s effectiveness, we conducted both in-lab experiments and a controlled user study with 31 participants and 17 *real-world* ABD issues together with 4 injected issues in 19 apps. The experimental results show that eDoctor can successfully diagnose 47 out of the 50 use cases while imposing up to 1.5% power overhead.

In conclusion, we believe execution phase is a promising perspective in troubleshooting ABD issues on smartphones. eDoctor executes this idea and demonstrates its efficacy.

## References

- [1] Facebook mobile app stats shocker. <http://goo.gl/8HKW7>.
- [2] X. Ma, P. Huang, X. Jin, P. Wang, S. Park, D. Shen, Y. Zhou, L. K. Saul, and G. Voelker. eDoctor: Automatically diagnosing abnormal battery drain issues on smartphones. NSDI, 2013.

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