EARMO: An Energy-Aware Refactoring Approach for Mobile Apps

Extended Abstract

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ABSTRACT

With millions of smartphones sold every year, the development of mobile apps has grown substantially. The battery power limitation of mobile devices has push developers and researchers to search for methods to improve the energy efficiency of mobile apps. We propose a multiobjective refactoring approach to automatically improve the architecture of mobile apps, while controlling for energy efficiency. In this extended abstract we briefly summarize our work.

KEYWORDS

Refactoring, Anti-patterns, Mobile apps, Energy consumption

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1 INTRODUCTION

Mobile apps play a central role in our daily living. Like other types of applications, the design quality of mobile apps is affected by poor design choices (a.k.a, anti-patterns), which impacts software evolution and hinder maintainability. One critical concern of mobile apps is the efficient use of energy. Recently, researchers have found evidence that refactoring could improve the energy efficiency of mobile apps [3]. In [2] we propose an approach (EARMO) to detect and correct anti-patterns in mobile apps, while improving energy consumption.

2 METHODOLOGY

The two main research objectives of this paper are ($O1$) to quantify the impact of anti-patterns on energy efficiency and ($O2$) propose an approach for removing mobile anti-patterns, while controlling for energy efficiency. To address $O1$, we perform an empirical study on 200 open-source Android apps, from which we selected 20, and 8 type of anti-patterns to measure the energy consumption of apps with/without anti-patterns using a physical measurement setup.To address $O2$, we formulate EARMO as multiobjective search-based approach and apply it to our testbed. We evaluate EARMO considering 5 dimensions: (1) percentage of anti-patterns corrected (2) precision of the refactorings suggested; (3) design quality improvement according to an external quality model (QMOOD [1]); (4) energy efficiency improvement measured in Battery life; and (5) usefulness of the refactorings proposed according to developers.

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3 FINDINGS

For $O1$, we observed that anti-patterns affect negatively the energy efficiency of mobile apps. For four types of anti-patterns the results are statistically significant, with large effect sizes. With respect to $O2$, EARMO was able to correct a median of 84% of anti-patterns detected, and achieved a precision of 68%. According to QMOOD, EARMO improved the extendibility of the studied apps by 41%. Concerning energy efficiency, it extended the battery life by up to 29 minutes when running in isolation a refactored multimedia app with default settings (no Wi-Fi, no location services, minimum screen brightness). Finally, developers of the studied apps considered 68% of the refactorings generated by EARMO, to be very relevant.

4 CONCLUSION

In [2], we studied the impact of anti-patterns on the energy efficiency on mobile apps. We found that anti-patterns affect not only design quality, but also the battery life of mobile devices. We proposed a multiobjective refactoring approach named EARMO to improve the design quality of apps, while controlling for their energy efficiency. We validated EARMO on a testbed of 20 open-source apps and found that EARMO could correct 84% of anti-patterns detected, and extend the battery life of mobile devices by up to 29 minutes. To validate the usefulness of the solutions found by EARMO, we submitted them to the authors of the studied apps and they found 68% of them to be very relevant. Finally, we provide a methodology to correctly measure energy consumption of mobile apps, and guidelines for toolsmiths interested in developing automated tools for improving mobile apps.

REFERENCES

[1] Jagdish Bansiya and Carl G. Davis. 2002. A hierarchical model for object-oriented design quality assessment. *Software Engineering, IEEE Transactions on* 28, 1 (2002), 4–17.
[2] R. Morales, R. Saborido, F. Khomh, F. Chicano, and G. Antoniol. 2017. EARMO: An Energy-Aware Refactoring Approach for Mobile Apps. *IEEE Transactions on Software Engineering* PP, 99 (2017), 1–1. https://doi.org/10.1109/TSE.2017.2757486
[3] Jae Jin Park, Jang-Eui Hong, and Sang-Ho Lee. 2014. Investigation for Software Power Consumption of Code Refactoring Techniques. In *The 26th International Conference on Software Engineering and Knowledge Engineering, Hyatt Regency, Vancouver, BC, Canada, July 1-3, 2013.* 717–722.