

# Research Summary

Safwat Hassan  
 Assistant Professor  
 University of Toronto, ON, Canada  
 safwat.hassan@utoronto.ca

Mobile applications (*apps*) are becoming an integral part of our daily activities. The mobile market is continuously growing, with an expected \$156 billion in revenue by 2023 [3]. With the mobile market's highly competitive nature, app developers need to avoid deploying buggy releases and continuously deploy high-quality releases that satisfy user needs. Over the years, the growing mobile apps market with millions of apps and billions of yearly downloads generates comprehensive data. Mining mobile app market data (e.g., analyzing user reviews) can help app developers improve their apps' perceived quality.

My research focuses on applying data mining techniques to the emerging software repositories (e.g., the app market data) to improve the perceived quality of software products. In the last six years, I have been working on providing techniques that can help app developers and store owners improve mobile apps' perceived quality in the following directions.

## 1. Analyzing Users' Feedback

We proposed approaches that help app developers proactively spot buggy releases and deploy fixes for such buggy releases [11, 20, 15]. Moreover, we proposed approaches to spot user complaints that may lead to user churn (i.e., migrating to competitor products) [9] and prioritize the required features based on the app's competitors [5, 12]. We proposed an approach to identify the topics of the raised issues in the bug reports [4]. We also proposed approaches to help app developers design mobile apps with a high-quality user interface (UI) [6].

## 2. Analyzing Developers' Common Practices

We studied the common practices of delivering main features in mobile apps, such as the patterns of writing release notes [22] and the patterns of integrating libraries [1, 2, 19] and machine learning libraries [18]. We also identified the common mistakes that lead to emergency fixes in mobile apps [13]. This work highlighted the importance of analyzing the store data on a large scale to automatically identify the deployed issues and recommend solutions to the identified issues.

## 3. Studying the Interactions Between Users and Developers

Responding to user reviews can improve the ratings of an app. However, with many daily user reviews, it is not practical to respond to all reviews. Hence, we proposed an automatic approach to predict reviews that are most likely to get app developers' responses [14]. We also studied developers' interactions using development communication platforms, such as the Gitter platform [8]. We proposed an approach that identifies discussion threads in communication platforms. Project maintainers can benefit from our work to spot the commonly repeated discussions and use such discussions to improve the documentation of their projects. To ease the replication of our study, we shared our dataset in our replication package [8].

## 4. Improving the Performance of Software Systems

We collaborate with IBM to provide approaches to enhance the performance of software systems [23, 10]. We also proposed different approaches to improve the design of software systems [16].

## 5. Adopting Mobile Apps for Healthy Life

We collaborate with medical practitioners to build mobile apps that adopt machine learning techniques to predict medical issues in users (patients). In addition, we propose approaches that provide proactive recommendations for patients and practitioners to avoid severe consequences of the predicted medical issues [7, 17].

## 6. Towards Rapid Releases of Software Systems

We analyzed the build results of 924,616 builds of 588 GitHub projects. We identified the best practices to improve the build performance of open-source software systems [21].

## References

- [1] M. Ahasanuzzaman, S. Hassan, C. Bezemer, and A. E. Hassan. A longitudinal study of popular Ad libraries in the Google Play Store. *Empirical Software Engineering*, 25(1):824–858, 2020.
- [2] M. Ahasanuzzaman, S. Hassan, and A. E. Hassan. Studying Ad library integration strategies of top free-to-download apps. *IEEE Transactions on Software Engineering*, pages 1–12, 2020.
- [3] B. O. Apps. App revenue statistics (2019). <https://www.businessofapps.com/data/app-revenues/>. (Last accessed: March 2019).
- [4] M. Assi, S. Hassan, S. Georgiou, and Y. Zou. Predicting the change impact of resolving defects by leveraging the topics of issue reports in open source software systems. *ACM Transactions on Software Engineering and Methodology*, pages 1–34, 2023.
- [5] M. Assi, S. Hassan, Y. Tian, and Y. Zou. Featcompare: Feature comparison for competing mobile apps leveraging user reviews. *Empirical Software Engineering*, 26(5):94, 2021.
- [6] Q. Chen, C. Chen, S. Hassan, Z. Xing, X. Xia, and A. E. Hassan. How should I improve the UI of my app? a study of user reviews of popular apps in the Google Play. *ACM Transactions on Software Engineering and Methodology*, 30(3):1–38, 2021.
- [7] N. Dekhil, Y. Mamatjan, S. Hassan, and M. Salih. A novel recommender system for strokerisk stratification. In *Proceedings of the 19th IEEE Conference on Computational Intelligence in Bioinformatics and Computational Biology (CIBCB)*, CIBCB '22, pages 1–2, 2022.
- [8] O. Ehsan, S. Hassan, M. E. Mezouar, and Y. Zou. An empirical study of developer discussions in the Gitter platform. *ACM Trans. Softw. Eng. Methodol.*, 30(1):8:1–8:39, 2021.
- [9] O. El Zarif, D. A. da Costa, S. Hassan, and Y. Zou. On the relationship between user churn and software issues. In *Proceedings of the 17th International Conference on Mining Software Repositories*, MSR '20, pages 339–349. ACM, 2020.
- [10] O. El Zarif, S. Hassan, Y. Zou, C. Zuzarte, and V. Corvinelli. Pred-cache: a predictive caching method in database systems. In *Proceedings of the 30th Annual International Conference on Computer Science and Software Engineering*, CASCON '20, pages 93–102. ACM, 2020.

- [11] S. Hassan, C. Bezemer, and A. E. Hassan. Studying bad updates of top free-to-download apps in the Google Play Store. *IEEE Transactions on Software Engineering*, 46(7):773–793, 2020.
- [12] S. Hassan, H. Li, and A. E. Hassan. On the importance of performing app analysis within peer groups. In *Proceedings of the 29th IEEE International Conference on Software Analysis, Evolution and Reengineering (SANER)*, SANER '22, pages 1–12, 2022.
- [13] S. Hassan, W. Shang, and A. E. Hassan. An empirical study of emergency updates for top Android mobile apps. *Empirical Software Engineering*, 22(1):505–546, 2017.
- [14] S. Hassan, C. Tantithamthavorn, C. Bezemer, and A. E. Hassan. Studying the dialogue between users and developers of free apps in the Google Play Store. *Empirical Software Engineering*, 23(3):1275–1312, 2018.
- [15] H. Hu, Y. Tian, S. Hassan, and D. Lin. Analyzing gamer complaints in reviews of cross-platform video games on steam. In *IEEE Conference on Games, CoG 2023, Boston, MA, USA, August 21-24, 2023*, pages 1–8. IEEE, 2023.
- [16] S. M. Ibrahim, S. A. Salem, M. A. Ismail, and M. Eladawy. Novel sensitive object-oriented cohesion metric. In *Proceedings of the 22nd International Conference on Computer Theory and Applications (ICCTA)*, ICCTA '12, pages 154–159, 2012.
- [17] S. Khan, N. Dekhil, E. Mamatjan, S. Hassan, and Y. Mamatjan. An automated online recommender system for stroke risk assessment. In *Proceedings of the 45th Conference of The Canadian Medical and Biological Engineering Society (CMBES)*, CMBES '23, pages 1–4, 2023.
- [18] A. K. McIntosh, S. Hassan, and A. Hindle. What can Android mobile app developers do about the energy consumption of machine learning? *Empirical Software Engineering*, 24(2):562–601, 2019.
- [19] A. Polese, Y. Tian, and S. Hassan. Adoption of third-party libraries in mobile apps: A case study on open-source android applications. In *Proceedings of the 9th IEEE/ACM International Conference on Mobile Software Engineering and Systems (MOBILESoft)*, MOBILESoft '22, pages 1–12, 2022.
- [20] I. Saidani, A. Ouni, M. Ahasanuzzaman, S. Hassan, M. W. Mkaouer, and A. E. Hassan. Tracking bad updates in mobile apps: A search-based approach. *Empirical Software Engineering*, pages 1–41, 2022.
- [21] S. H. Taher A. Ghaleb and Y. Zou. Studying the interplay between the durations and breakages of continuous integration build. *IEEE Transactions on Software Engineering*, pages 1–12, 2023.
- [22] A. Z. Yang, S. Hassan, Y. Zou, and A. E. Hassan. An empirical study on release notes patterns of popular apps in the Google Play Store. *Empirical Software Engineering*, pages 1–41, 2021.
- [23] G. Zhao, S. Hassan, Y. Zou, D. Truong, and T. Corbin. Predicting performance anomalies in software systems at run-time. *ACM Transactions on Software Engineering and Methodology*, 30(3):1–33, 2021.