

Exploring Code Samples Characteristics and Their Impacts on Software Ecosystems

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Abstract. *Code samples are made available to assist developers to accelerate the learning process of features provided by frameworks. However, we know little about how code samples are developed and consumed. In this paper, we aim to fill this gap by assessing the characteristics of framework code samples. We provide insights into how code samples are maintained and used by developers. We find that most code samples are small and simple, and provide a working environment. They frequently change, for example, to adapt to new framework versions. To further understand the problems faced by developers, we analyze Stack Overflow and 269 issues from code sample repositories. We find that developers face problems when modifying the code samples and the most common issue is related to improvement.*

Resumo. *Para acelerar o processo de aprendizagem das funcionalidades fornecidas pelos frameworks, code samples são disponibilizadas para auxiliar os desenvolvedores. No entanto, sabe-se pouco sobre como code samples são desenvolvidos e usados. Neste artigo, pretende-se preencher essa lacuna avaliando as características dos code samples. Fornecendo informações sobre como os code samples são mantidos e usadas pelos desenvolvedores. Descobriu-se que a maioria dos code sample são pequenos e simples, fornecem um ambiente de trabalho. Eles mudam frequentemente, por exemplo, para se adaptar a novas versões do framework. Para entender melhor os problemas enfrentados pelos desenvolvedores, analisou-se o Stack Overflow e 269 issues dos repositórios dos code samples. Descobriu-se que os desenvolvedores enfrentam problemas ao tentar modificá-los e o problema mais comum está relacionado à melhoria.*

Introduction: In the present text, we abstract an article published in the Journal of Systems and Software in 2022. [Menezes et al. 2022] Currently, software systems are often built with the help of frameworks. The use of these platforms can provide reuse of features to increase productivity and reduce development costs. Organizations provide code samples to facilitate and accelerate the learning process of their products. Code samples are software projects with an educational purpose, made available with the objective of helping developers understand, use, and keep up to date with the functionalities of the organizations' products. Code samples are official documentation provided by the organization and presents educational purpose, aspects that show the importance of code samples to the community. Although this importance, some code samples aspects are

fill explored. For example, we do not know about how they are maintained and used by developers. In this context, some questions are raised: (RQ1) What are the source code characteristics of code samples, compared to conventional projects? (RQ2) How do code samples evolve over time, compared to conventional designs? (RQ3) How are code samples used by developers, compared to conventional designs?

Method: First, we selected the organizations and code samples to be analyzed. Our final selection results in 233 code samples, being 176 from Android framework and 57 from Spring Boot. To compare with code samples, we selected conventional Android and Spring Boot projects maintaining the same proportion. In addition, we selected 614 Stack Overflow questions related to the same set of code samples. To answer RQ1, looking for the last commit, we extracted three metrics: source code metrics, number of file extensions and number of configuration files. To respond RQ2, we extracted the same set of metrics, but looking for all commits. Still on RQ2, we also computed the time taken to project become up to date with new framework version. To answer RQ3, first, we computed the number of forks and analyzed changes on these forks. Second, we conducted qualitative analysis, using thematic analysis, to categorize code sample questions on Stack Overflow. In a similar way, we analyze code sample issues on GitHub.

Results and Implications: Based on our findings, we provide a set of implications to framework code sample creators and clients to support their maintenance and usage practices: **Code samples should be simple and small to facilitate their reuse**, as stated by good development practices. Indeed, the majority of the code samples provided by Android and Spring Boot follow this rule. However, this is not strict: we find that the code samples with more Java files are more likely to be popular than those with fewer Java files. **Code samples should provide working environments to ease their usage.** Most Android and Spring Boot code samples are formed by source code and many other configuration files necessary to run them properly. Automated build and integration tools may also support both the creators and clients, improving their quality and reducing risks. **Code samples are not frozen projects, but they should be updated over time.** Changes are commonly performed to follow recent framework versions, otherwise, the code samples become outdated and less attractive to the clients. Indeed, this practice is often performed by Android and Spring Boot code samples, but much faster in the latter. We also find that the code samples that are changed frequently are more likely to be popular. Our qualitative analysis on Stack Overflow and GitHub issues also suggests that the code samples are likely to change over time due developers' needs. **Code sample creators can provide extension guides to aid developers.** We found that developers frequently try to modify or improve the code samples but face some problems, for instance, expanding the sample with novel new features. We also detect that developers may even suggest the improvement of code samples via GitHub issues. Maybe developers would not create these questions if organizations made available extra content explaining how to evolve code samples, including the use of different related features (more complex use of common features). This could help to spread the technology and also to support developers.

Referências

Menezes, G., Cafeo, B., and Hora, A. (2022). How are framework code samples maintained and used by developers? the case of android and spring boot. *Journal of Systems and Software*, 185:111146.