Software Engineering in the IoT Context: Characteristics, Challenges, and Enabling Strategies

Summary

The Internet of Things paradigm has given rise to a programmable world. The idea of embedding computing and communication capabilities into objects of common use has led to the development of a broad range of solutions in several domains. However, from a technical point of view, IoT systems are difficult to implement. They are typically composed of four architectural elements (devices, gateways, cloud services, and applications), and the implementation and orchestration of these architectural elements rely on several enabling technologies and spans across multiple development and execution environments. Consequently, due to the co-existence of various kinds of devices, protocols, architectures, and applications, IoT developers are required to become proficient in various and disparate areas and to consider several dimensions that are unfamiliar to most software developers.

The objective of this dissertation is to gain an understanding of the key characteristics and the most challenging issues of IoT systems development and, consequently, to propose strategies aimed at supporting the developers to overcome the complexity inherent in the development of IoT systems, and in this manner, harnessing the programmable world full potential. To that end, the first part of this thesis presents the results of an *IoT developers survey* aimed at identifying the most challenging development tasks, based on individual and group experience of 40 novice developers that worked developing IoT systems for several years of a university course. Besides, qualitative data about the causes of the identified issues were collected and analyzed. Additionally, the thesis reports a quantitative analysis of a broad set of some of the most popular publicly available IoT *Open Source Software repositories* to provide insights into the purpose and characteristics of the code, the behavior of the contributors, and the maturity of the IoT software development ecosystem.

Upon the findings of these approaches, in the second part of the thesis are proposed: *Code Recipes*; a documentation strategy for the IoT aimed at overcoming the lack of documentation understandable by inexperienced IoT developers, and *IoT Notebooks*; an IoT-tailored literate computing approach to support the prototyping of IoT systems by enabling developers to build and share a computational narrative that may span across multiple developments and execution environments.