Automated Online Learning of Python Programming: An Application of Context Aware Computing over Mobile Platforms

Submitted by

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**Abstract**

The aim of this project is to explore an innovative way to create a context aware system to teach Python programming through an Android application. When self-studying, one of the main issues with tutorials and virtual classes is that they often go over more material than is necessary, especially when a user has prior knowledge. By creating a context aware learning system, the order in which lessons are presented will be able to adapt to a user’s personal aptitude for the content. For someone who self-studies, such a system could greatly increase learning efficiency by only showing users material that is relevant to their current knowledge. During the creation of such a system, it would be imperative to also explore efficient application design to facilitate programming on a mobile device. Such research will assist in the expansion of programming to mobile devices, thereby benefiting mobile programmers.

**Current Research**

As mobile devices become more advanced, and their computing power begins to rival traditional desktop computers, some researchers argue that computer programming itself should be done directly on mobile devices (Tillmann et al. 156). As they put it, students will soon be more likely to carry with them a smartphone than a laptop. As such, it only makes sense that new programmers should be able to learn programming on their mobile devices as well. To achieve this, there are a number of practical concerns that one must address. The smaller screen of a mobile device leaving less room to view code, typing on a small screen without an external keyboard, and a mobile device being more constrained by battery life than a PC are just some of the dilemmas when it comes to programming on a mobile device.

One proposed solution is a mobile development environment known as TouchDevelop that can be used to create mobile applications for the Windows phone platform. By providing the programmers with layered views of the code, TouchDevelop reduces the amount of code that needs to be displayed on the screen. Moreover, the semi-structured code editor enables the user to navigate the code more easily and type less (Tillmann et al. 1-2). However, there are limits to the applicability of TouchDevelop as it does not address a mobile device’s limited battery life, nor can it be used in a more general context outside the scope of its own language and target platform.

AppInventor is another proposed solution which presents a simplified approach to programming in the form of a block editor, eliminating the need to type code. It also uses a centralized server to store and compile programs (Perdikuri 1-6). However, AppInventor is designed for building Android applications in the web browser, and still has the drawback of needing to scroll through many code blocks the more complicated a project gets**.**

One group of researchers implemented a new type of Python exercise on top of MobileParsons to allow mobile users studying Python to toggle between alternative lines of code to solve exercises (Ihantola, Helminen, and Karavirta 51-58). These exercises are simple enough to not clutter the screen, there is relatively little user input required (compared to typing code), and there is no need for intense computations since the exercises are all pre-designed. However, it is limited in its scope: that is, it is restricted to the predefined exercises and cannot be generalized to other programming applications.

This thesis seeks to bridge some of the ideas presented above by creating a user-driven context aware system that will teach Python on the Android platform. Because the mobile platform has a dynamic set of variables that differ from user to user, it is necessary to create a context aware system that will adapt to improve a user’s individual experience (Abusair 1022-1025).

**Aims and Objectives**

***Introduction***

Some existing mobile applications provide programming functionality to some extent, but they are limited to specific use cases or lack the context awareness that would improve the user’s experience. Developing a prototype in the form of a context aware Python learning application will provide a template for context aware systems being implemented on the mobile platform. To accomplish this, the following aims and objects must be met.

***Aims***

1. To identify context variables associated with mobile application use.
2. To examine existing techniques for user data acquisition.
3. To investigate methods of mobile application optimization as a means of addressing the inherent performance issues of mobile devices.
4. To address the limited screen size of mobile devices by designing an efficient user interface.
5. To design a set of practical Python lessons of varying degrees of difficulty.
6. To develop a functional prototype for a context aware system that will create an individualized experience for the user.

***Objectives***

1. To create a context aware system that is able to adjust itself to improve a user’s experience, it is necessary to first identify what external stimuli are associated with the mobile platform. The context aware system will use these context variables to identify the aptitude of the user and adjust itself accordingly.
2. Before context data can be collected, it is essential to first understand how to collect such data, from both the user and the mobile device.
3. One critical weakness of a mobile device (when it comes to processing) is that it is reliant on battery power. To overcome this weakness, it is necessary to optimize a mobile application so that it uses less system resources, and thus performs better for a longer period of time.
4. The relatively small size of mobile screens, and the lack of lack of a full-size keyboard, severely limit the user’s ability to program. To address this issue, it is necessary to develop an intuitive interface that provides mechanisms which reduces the amount of typing a user must perform.
5. While Python is a relatively easy language to teach and understand, it is not feasible to try to teach everything about Python to a user. Thus, it is necessary to narrow the set of Python lessons the context aware system will teach to a smaller set of lessons of increasing difficulty. The increasing difficulty of the Python lessons will be necessary to allow the system to designate appropriate lessons to users of varying aptitude.
6. Developing a prototype for this system will be necessary to substantiate the feasibility of such context aware systems being implemented on mobile devices.

**Methodology**

First, it will be necessary to identify what types of context variables can be obtained from an application user and from the platform the application runs on. To do this, additional research will need to be performed to understand what user input can be efficiently gathered and analyzed, as well as identifying what mobile specific variables may be of interest. To further understand user data collection, it will be useful to create smaller android apps, web applications or Python scripts with varying interfaces that take in and analyze user data. During this step, rudimentary user interface (UI) design and context aware implementations should be explored. These trial applications will serve as the foundation for the final prototype.

The next step will be to gain an understanding of android application optimization and improve UI design. If prior research is not enough, some time will be spent researching previously implemented optimization strategies. Then, the focus will be on laying out an optimization strategy and implementing it. This may include setting up an external server and learning how to communicate with it through the android application, which may require additional time. Understanding optimization early on will save time later on, as optimizing an existing project requires extra energy and time. To address efficient UI design in the context of mobile programming, it will be helpful to review the best practices used to develop the TouchDevelop UI and make changes as necessary to facilitate project needs.

Finally, the focus will be on designing and implementing the final prototype of the android application. This will require finalizing the UI and selecting a sample of Python lessons to implement into in the application. The application will then need to be programmed to present lessons to the user in a context aware manner using the context variables collected previously to gauge a user’s aptitude for the material being taught.

After performing quality assurance testing on the application to ensure it functions satisfactorily, the last step will be writing up any missing documentation. This documentation will then be combined with the android application to provide a prototype for a context aware system on the mobile platform that can be easily recreated and/or modified.

**IRB**

I am not seeking IRB approval.

**Outcomes**

The primary outcome of this research will be a model providing environmental support for programming on a mobile device that addresses the aforementioned issues inherent to programming on the mobile platform. Furthermore, an Android application that provides user-based adaptiveness to teaching Python will be created to verify the feasibility of the model. This prototype will not only enable new programmers continue learning as they travel but could also serve as an example for future researchers wishing to expand the model into other programming domains. On a more personal note, this project will allow me to explore the Android Java and Python programming languages in greater detail, both of which enjoy high probability to be applicable to both future research or development work.

**Biography**

My name is Miguel Millan and I am currently a senior in the School of Engineering and Computer Science at Oakland University majoring in computer science with a minor in Japanese. After graduating, I intend to pursue a PhD in computer science and informatics here at Oakland University. To this end, the Honors College thesis will serve as a good introduction to graduate research by allowing me to get a jump start in contributing to some of the current mobile technology being actively researched.

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