

A Learning Analytics Framework for Practice-Based Learning

Giacomo Dabisias, Scuola Superiore Sant'Anna, giacomo.dabisias@sssup.it
Daniel Spikol, Malmö University, daniel.spikol@mah.se
Emanuele Ruffaldi, Scuola Superiore Sant'Anna, emanuele.ruffaldi@sssup.it

Abstract: The role of the PELARS Learning Analytics System (LAS) system is to collect information from students performing project-based tasks, reason on such information and provide visualization to teachers and students, that is usable for understanding the learning process. The information collected by the LAS comprises pieces of information collected directly by the Students, and other collected by the System automatically. In this work we will provide a comprehensive description of the framework and the motivations behind the various decisions. The software framework will be described starting from the broad vision of the context and then the different components will be described in detail.

Keywords: learning analytics, action recognition, Arduino, Kinect, software framework

Introduction

This paper has two main objectives. The first one is to provide a description of the PELARS software framework architecture, the second a preliminary description of the Learning Analytics concepts and metrics that can be addressed by the framework. The core idea of the system is to process the raw data acquired in the learning environment that a server will collect to produce learning traces that, based on the identified metrics, can be employed, by the teacher, to better understand the learning process and, by the students, to document their work. Students will work in small groups on a fixed task using Arduino components. Previous related work has shown promising results (Christodouloupoulos, 2007).

Software framework

The framework has been designed by first defining the system context with the involved entities, then defining objectives and requirements and finally proceeding with the use cases. This initial analysis allowed then to define the system components and their interactions.

Requirements

The basic system requirements are: (1) the integration of different sensors in the Learning Environment (LE) to acquire information about the ongoing learning process; (2) the support of flexible curricula and configurations; (3) the collection from multiple sites at once; (4) the extensibility for supporting new components that extract learning traces and performance indicators; (5) easy to be understood visualization for the students and the teachers; (6) the support for real-time and deferred visualization and evaluation of the acquired Learning Metrics.

General architecture

Provided the above description in terms of Context and Requirements it is possible to identify the high level view of the Pelars LAS. The LAS contains a subsystem called LE that corresponds to the location where the students are working on a project. In this location the following elements have been identified: the furniture in which the LAS will be integrated; the Arduino Kit for the experiments; a Collector, which collects all the information gathered by the LAS and the Sensors, which analyze the scene and extract relevant information about objects and actions. The final results are available for the Teachers through a Web Interface. A more general framework in which adaptation is present can be found in (Bienkowski, 2012).

Learning environment

The LE comprises a series of elements that contribute to the learning experience while, at the same time, collect information about the activity of the students. The sources of information for the LAS are constituted by sensors embedded in the furniture. In the following sections the details of the different blocks will be described, together with their interconnections.

Programming IDE

The programming IDE is the tool used by the students for interfacing with the code and developing the projects. The main IDE used in Pelars will be the Arduino IDE with variants developed in the context of PELARS to extract information about the programming tasks in the form of packets sent to the Collectors.

Desk and vision sensors

Desk sensors will be used to track the position and number of hands active in the LE. The Leap Motion Sensor (Guna, 2014) represents a possible solution [3], which is able to acquire in real-time the position of each hand segment inside a fixed volume. Each Sensor can capture around four hands, but without the knowledge of hand pair, meaning that each hand is a separated hand. Possibly more sensors will be embedded in the LE to cover the majority the working area. Position sensors, like RFID, will help to track the position of Arduino components inside the system.

A Vision Sensor is intended as a RGB-D camera, which is able to capture a 3D image of the environment. It will be used to gather knowledge of the relative and absolute position of Arduino components and other used instruments in the LE and to track the movement of the components.

Collector

The Collector is a piece of software responsible of acquiring the information produced by the different sensors and of elaborating the data in order to extract the Learning Metrics. The collector will be a stand-alone application which collects and processes information from the various sensors (Vision and Desk) and the Arduino IDE. All the information extracted by the Collector will be sent to the Server deferred, or in real-time.

Server

The Server will be a dedicated machine hosting a Web Server and a database. Inside the Web Server three Applications will be executed: the Acquisition App that receives data from the Collector and stores into the Database, the LA Core App that performs computations over the acquired data and a Web App that provides the front-end to the user. The Web App provides mainly two types of services: the Administration of the LAS and the Visualization of the learning traces in the form of dashboard or custom visualizations.

WebApp

The Web Server will export a web interface, accessible from any computer, for Teachers that will be able to manage the collection of data from learning sessions and visualization of data. The Visualization is based on two concepts: the Dashboard that allows the users to visualize the key elements about a group of students, and a Traces Visualization that presents the information collected for a given user along.

Conclusions and implications

It is important to notice that the Learning Analytics Framework is in a preliminary stage and needs further development based on the Learning Analytics Metrics, which are currently researched. The structure has been developed trying to maintain it modular and expandable, but also able to scale well with the possible increase of concurrent LEs and new Learning Analytics Experiment Kits. How to evaluate the results of the test is still in development topic and will be researched during the development of the framework.

References

- Christodoulopoulos, C. E., & Papanikolaou, K. A. (2007, October). A group formation tool in an e-learning context. In *Tools with Artificial Intelligence, 2007. ICTAI 2007. 19th IEEE International Conference on* (Vol. 2, pp. 117-123). IEEE.
- Bienkowski, M., Feng, M., & Means, B. (2012). Enhancing teaching and learning through educational data mining and learning analytics: An issue brief. *US Department of Education, Office of Educational Technology*, 1-57.
- Guna, J., Jakus, G., Pogačnik, M., Tomažič, S., & Sodnik, J. (2014). An Analysis of the Precision and Reliability of the Leap Motion Sensor and Its Suitability for Static and Dynamic Tracking. *Sensors*, 14(2), 3702-3720.

Acknowledgments

The Project is a European Union Research Project for Small or Medium-scale Focused Research Project (STREP) part of the FP7-ICT-2013-11 Objective ICT-2013.8.2 Technology-enhanced Learning. The Grant Agreement number is 619738. <http://www.pelars-project.eu/>