IITE-2014
14-15 October • Moscow • Russia

A recommendation model on personalised learning to improve the user's performance and interaction in MOOCs and OERs

Daniel Burgos and Alberto Corbí

Universidad Internacional de La Rioja (UNIR)

{daniel.burgos;alberto.corbi}@unir.net

Abstract: Current models and methodologies in the field of educational technology are lacking in engagement between formal and informal learning. Usually, only activity within a formal environment (i.e., assignments, grades, et cetera) is stored, tracked and retrieved as an input parameter in recommender systems. However, there is normally one issue missing: a useful combination with the informal activity of every user (e.g., social networks, continuous evaluation). In addition, tutoring systems in academic domains are usually based only on content filtering and collaboration from other students, which we believe contribute to dissolving the crucial role of the tutor. Last, OERs, MOOCs and SPOCs have become a crucial part of combined educational models, between formal and informal settings, where they play a key role in the learning path of every user. Thanks to the user's behaviour and the user's interactions, efficient monitoring and personalized counselling by a tutor, we can improve the learning performance of every user. In this paper, we show a specific implementation of LIME, a personalized elearning model for restricted social networks and learning management systems, which supports this approach, specifically for massive courses and large data sets. Furthermore, we present the practical application of the model into a prototype (iLIME), which has been developed to demonstrate how our model could operate independently of the learning management infrastructure in use. This application case is developed under the Sakai LMS, in the context of a MOOC strategy to be implemented at university level. We provide pedagogical and technical issues, challenges and solutions, developed in order to run iLIME and deliver LIME-based recommendations to learners in a real academic scenario, focused on open educational resources and massive courses.

Keywords: informal learning, recommendation, massive open online courses, open educational resources, conceptual educational model, rule-based recommender system, social interaction, learning tool interoperability, user monitoring

1 Introduction

In this work, we present a rule-based elearning recommendation model named LIME. LIME segments the student journey in an online campus, OER or MOOC environment into four categories: Learning, Interaction, Mentoring and Evaluation, and takes into special consideration both formal and informal settings undertaken in a course site or class group. Each category and setting is assigned a specific weight, according to teacher/tutor professional and pedagogical discernment.

Rules in LIME are fed with inputs that are the result of monitoring students' activities and actions (both formal and social) on the elearning platform. Each input is also classified by the tutor, in line with the LIME model, and assigned an individual load. When rules are triggered, inputs are weighted by the model's fundamental parameters, are then filtered and a recommendation is finally issued to the student. That is, based on what the user does in the system and how it is surfed, the model provides the user with personalized guidance, dynamic along the timeline, which allows for stable tutoring support throughout the learning process.

In order to validate the LIME model, we have designed a framework called iLIME, which is proof of the validity of the concept on the LMS Sakai CLE (as an IMS LTI compliant provider tool). iLIME is designed to work with real end-users and learning management systems. This real and practical setup of our recommender model allows for a further refinement of the model and leads to an improvement of the student's average performance. Over the course of this paper, we have discussed all the technical issues faced, choices taken and concessions made in order to implement iLIME on the aforementioned LMS but also with the view to pave the way for more upcoming practical and architecture-independent deployments, OERs and MOOCs engines included.

2 State of the art

Informal learning and social interaction are receiving increasing attention in current elearning campuses and platforms. Massive Open Online Courses (MOOCs) and Open Educational Resources (OERs) are no exception [Bry 13]. In plain online campuses, students now have a wide range of options for social actions and group collaborations at their disposal: post/answer questions in forums, start their own activities, create their own sites, wikis, invite colleagues, comment on someone else's job, score jobs made by others, incorporate external materials to their knowledge repository, fill in questionnaires, participate in WebRTC sessions with teachers, et cetera. Small Private Online Course (SPOCs) and locally deployed Learning Management Systems (LMS) already allow almost endless possibilities in humble environments. These can grow exponentially in an x/cMOOC setting which can potentially manage thousands of learner accounts around common learning material.

Based on this background, we design and develop a conceptual and personalized learning model, LIME, which is based on four ponderable categories: *Learning* (L), *Interaction* (I), *Mentoring* (M) and *Evaluation* (E). As we will elaborate upon later, these contributions are the pillars for any learning scenario along with their formal and informal settings. Our approach provides the student with adaptive tutoring and support via a simple and fine-grain configure-able rule system. In addition, students are monitored as well as their interactions through the elearning platform, which efficiently gathers necessary inputs [Burgos 07, Rocchio 71], such as actions, decisions, grades, communication, and others. By combining rules, tracking data, categories and settings, students ultimately receive personalized counselling about their academic path.

The model also provides added value from other recommender approaches [Linden 03, Marlin 03] in online education by delegating to the teacher/tutor/manager the following actions:

- Design of the rule set.
- Distribution of a percentage contribution to each category and setting.
- Configuration of site inputs and monitoring strategies accordingly.

In short, LIME is a tutor-assisted framework for student guidance and, as with other recommender systems, its goal is to improve learning efficiency [Chen 05, Ghauth 10, Kerkiri 07, Romero 03]. In this paper, we lay out a model for personalized tutoring, with a special focus on the combination of formal and informal settings in a combined paradigm. We believe our recommender model suits both SPOCs and MOOCs by giving the tutor complete control over his/her specific course characteristics, ambitions and flow. This control is attained through a set of custom rules appropriately parameterized with learner monitoring information, categories and weights. Finally, from a technical point of view, LIME, as a software add-on, has been designed with a focus on cloud campuses and MOOCs with high enrolment and participation rates, as we will justify later.

3 The LIME recommendation model

The L.I.M.E. model, presented in [Burgos, 13], is grounded on three separate pedagogical components, strongly evident in all stages of education:

Learning, or what every learner needs to do in order to assimilate and build knowledge on his or her own.

Interaction, or relationships established, activities and academic interaction between students, leading to the acquisition of knowledge and competencies.

Mentoring, or what teachers/tutors give relevance to.

Evaluation, or officially graded activities (tests, exams, problems sets, et cetera).

Teachers/tutors must design a strategy for each of his/her courses. We have codified this strategy by using the following terminology:

Setting: Balance between formal and informal settings: the system collects specific inputs from both settings, keeping an overall balance of 100%. For instance, if the designer requires just a formal setting, the balance should be Informal: 100% - Formal: 0%.

Category: Balance between Learning, Interaction, and Mentoring categories. In the L.I.M.E. model, every category is assigned a specific weight, keeping an overall balance of 100%. For instance, if individual and group actions matter alike, and there is no mentoring, the balance should be Learning: 50% - Interaction: 50% - Mentoring: 0%.

Input: List of specific inputs for each **category** and assigned **weight**. Every input should reflect a specific action that was undertaken, an event that happened, a grade assigned and/or result obtained by a student in the learning platform.

An example of the model configuration for a specific site can be found in Figure 3b. Based on these components, tutors can *manually* define and parameterize recommendation rules, which will only trigger a recommendation if conditions regarding categories, inputs and settings are met.

Thus, LIME is a tutor/teacher crafted, rule-based recommender system for cloud learning environments (OERs, SPOCs, MOOCs), which contrasts with other approaches [Lenoy 13, Sielis 11].

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