

Bucharest University of Economic Studies

**Economic Informatics Doctoral Domain
Economic Informatics Doctoral School**

HABILITATION THESIS

**User Profile Recognition on Learning Platforms using
Advanced Analysis and Technologies**

- ABSTRACT -

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The thesis *User Profile Recognition on Learning Platforms using Advanced Analysis and Technologies* presents a synthesis of the concerns, scientific and professional results, published after obtaining the doctorate in the field of Economic Informatics, in 2014, with the doctoral thesis *Quality Metrics of Mobile Applications*, carried out under the guidance of prof. Ion IVAN, Ph.D. The 2020-2022 COVID-19 pandemic has caused many of the activities to be moved online. Thus, the educational system has had to increasingly use educational platforms to deliver content to students online.

This thesis presents the way of using educational platforms using analysis and advanced technologies.

The habilitation thesis comprises three distinct sections and has the following structure:

1. Section I - Scientific, professional and academic achievements includes two chapters in which these achievements are presented in two thematic disciplinary directions:
 - User Profile Recognition for Learning Platforms - includes three sub-chapters addressing user recognition issues within online platforms used in the educational environment:
 - In this chapter propose a users' recognition model in online applications based on their behavior characteristics is proposed. For establishing the user profile recognition, there are defined the behavior characteristics in the case of online applications and these characteristics will be followed within some testing applications. Based on the identified characteristics, measurements are performed for each user. The measurements are saved in a database and by calculation of an average, a profile is achieved. In the case of future user' authentications in the application, the behavior measured in the current session is compared with the profile saved in the database. The purpose of this chapter is to determine patterns of user behavior analysis and to compare the current behavior with the profile from the database using the Euclidean distance calculation formula. The obtained results are published in Zamfiroiu, A., & Ciurea, C. (2017).
 - the second subchapter presents the behavior of users within social platforms. Given the increase of sensitive data stored within mobile devices and social media applications, the need for creating a user behavior profile is in high demand for preventing security breaches, impersonation or unauthorized access to resources. The behavior of a user is defined by the aggregation of different patterns that are obtained while constantly using a software service on a mobile device or a computer. The scope of this study is to identify a core group of characteristics that can be further used in profiling a user based on his behavior. For that, a survey consisting of 20 questions was conducted having a set of 356 responders. The obtained data were pre-processed and used as input for supervised and unsupervised classification techniques. Two applications, one web-based and one mobile,

were implemented in order to expand the prior selection of characteristics and to verify the obtained results. They were used to measure interaction events and ways of using social media on both versions of the applications. Considering these different behavior-based characteristics, different groups of users that are uniquely identifiable by limited sets of characteristics are defined. The results of this study are published in Boja, C., Zamfiroiu, A., Zurini, M., & Iancu, B. (2019).

- the third subchapter presents a prototype educational platform made for recognizing students based on behavior within the educational platform. The COVID-19 outbreak is an international problem and has affected people and students all over the world. When lockdowns were imposed internationally, learning management systems began to be used more than in the previous period. These systems have been used also for traditional forms of learning and not only for online learning. This pandemic period has highlighted the need for online learning systems in the educational environment, but it is very important for these systems to be secure and to verify the authenticity of the students when they access a course or evaluation questions. In this period, everything is moving towards the digital world, with students who are remotely connected to online systems. All activities in the educational environment will soon be performed digitally on learning management systems, which includes also the evaluation process of the students. In this chapter a secure learning management system that uses the student's behavior to identify if he/she is an authentic student or not is proposed. This system can support the teacher's activities in the learning process and verify the authenticity of the students logged on to the system. This platform is presented in Zamfiroiu, A., Constantinescu, D., Zurini, M., & Toma, C. (2020).
- Technologies and solutions for advanced analysis - also includes three sub-chapters in which different solutions and advanced analysis technologies are presented for the data obtained following the establishment of student profiles within online educational platforms:
 - the first subchapter presents an analysis of the most important vulnerabilities that educational platforms present and an analysis of students' awareness of them. The rapid adoption of e-Learning platforms, exacerbated by the COVID-19 pandemic, has highlighted the critical need to enhance cybersecurity awareness within educational environments. This research investigates the evolution of cybersecurity risks and threats in e-Learning settings, comparing the pre-pandemic landscape with the and post-pandemic one. The challenges posed by the sudden shift to remote learning and the resulting impact on the cybersecurity posture of the educational

institutions are identified through a comprehensive analysis of data and trends. The present study examines the measures taken to mitigate these risks, including security awareness programs and technological enhancements. By evaluating the efficacy of these measures, this chapter provides valuable insights into safeguarding e-Learning ecosystems against cyber threats. The findings underscore the necessity for ongoing vigilance and preparedness in an ever-evolving digital educational landscape. The analysis carried out is presented in Barbu, M., Zamfiroiu, A., Marinescu, I.A., Iordache, D., Bumbac, R. (2023).

- the second subchapter presents an analyse of the Time Series Databases (TSDB), that are a particular type of data repositories. TSDBs are capable of diverse functionalities regarding operations on time series data and are developed using different technologies. A large number of TSDB solutions has emerged in the last years, available as open source and commercial. Selecting the proper TSDB is a challenging endeavour for a potential enterprise client. In this subchapter, a set of open-source TSDBs which includes InfluxDB, Graphite, RRDTOOL, Prometheus, OpenTSDB and TimescaleDB - has been selected for analysis, evaluation and ranking. A comparison of TSDBs implies the establishment of a set of attributes. A set of quantitative and qualitative attributes which have different scales and units of measure has been selected. The problem of selecting or ranking TSDBs evaluated in this part of the research with a set of attributes is a Multi-Attribute Decision Making problem (MADM). For solving the TSDBs evaluation, analysis and selection a multi-attribute TSDBs maturity model has been proposed. The model for the selected TSDBs set and for the 18 attributes, 10 quantitative and 8 qualitative, has been validated. The model for all the attributes, both quantitative and qualitative, has been solved and, finally, a comparison between the obtained rankings has been made. The comparison of the ranks obtained are presented in Petre I., Boncea R., Radulescu C.Z., Zamfiroiu A., Sandu I. (2019).
- the third subchapter presents an automatic analysis carried out for scientific articles that have a theme in the field of security. The Cybersecurity is a major concern in the field of information and communication technology. Topics like risk, vulnerability, exploit, attack, threat are related to security, thus revealing its complex nature. In order to take better security measures, vulnerabilities have to be identified. These topics are the subject of research papers in journals, and of Master's, doctoral and postdoctoral theses. This chapter proposes a model and several metrics for the analysis of topics related to vulnerabilities in scientific papers. This model has been validated based on an automated tool, by analyzing over 400 research papers. The

Common Vulnerabilities and Exposures (CVE) database was used as the main reference source for the existing vulnerabilities. The used model can be used for scientific articles written in any field and is presented in: Pocatilu, P., Zamfiroiu, A., & Apostol, V. (2020).

- the last subchapter presents a model for analyzing student behavior within educational platforms. Online education is one of the fastest emerging markets globally. There are a variety of tools, technologies and platforms, which augment learning in the online environments. This has a strong boost with mobile technologies, becoming widely accessible and with affordable prices for the data plans. Mobile devices are among the top choices of learners from the current generation. Moodle and Sakai are probably the most popular open-source learning management systems (LMS) around the world, although there are also some alternative professional solutions such as TalentLMS or other platforms. Moodle/Sakai provides a good platform for content administration, along with management of learning and assessment. Student interaction is one of the success factors of effective online teaching and learning. It is important to understand how students behave in an online environment. This provides good feedback to the syllabus developers and instructors, in order to examine what should be improved. The learning management systems provide a good way for analyzing learners' behavior through log reports. The LMS records all kinds of interactions of all users. By processing this big data using learning analytics, a good picture of what progress is achieved by the students during the lectures and the laboratories and how the professors manage the students' learning curves is obtained. This chapter explains the use of learning analytics in examining the engagement, interaction and behavior of learners in an online environment, where the professors and admins record and analyze the log records of learners as a part of their attempting of the Quizzes / Tests or assessments from their course. The results revealed interesting findings on how the assessment should be organized, in order to find maximum learning attainment. These results are presented in Zamfiroiu, A., Sharma, R. C., Constantinescu, D., Pană, M., & Toma, C. (2022).

2. Section II - Professional, scientific and academic career development and development plans

This section presents the evolution of my scientific and academic career as well as plans for future evolution and development. The research projects I was involved in and the subjects I taught are presented.

3. Section III - presents the list of bibliographic references associated with the content. Some of these are the author's publications.

