A Context-Aware Self-Adaptive Fractal Based Generalized Pedagogical Agent Framework for Mobile Learning

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ABSTRACT

The Pedagogical Agents (PAs) for Mobile Learning (m-learning) must be able not only to adapt the teaching to the learner knowledge level and profile but also to ensure the pedagogical efficiency within unpredictable changing runtime contexts. Therefore, to deal with this issue, this paper proposes a Context-aware Self-Adaptive Fractal Component based Generalized Pedagogical Agent (CASA FBGP A) framework for Mobile Learning. The proposed framework allows for the construction of PA that self-reconfigures its structure, the functional part, to conform to the unpredictable changing runtime context. To carry out the context-awareness, the PA embeds a distinct Search based Adapting Engine that dynamically monitors and assembles the appropriate linear combination of Fractal components. In addition, to avoid the rules associated conceptual holes, to deal with the conflicting objectives and to reduce the substantial overhead, the components selection is formulated as a multiobjective problem and it is tackled using a metaheuristic search method. Furthermore, to evaluate the design and the feasibility of the proposed framework, a use case and a discussion are provided.

Keywords: Fractal Based Generalized Pedagogical Agent, Fractal Model, Mobile Learning, Pedagogical Agent, Search Methods

1. INTRODUCTION

The Pedagogical Agents (PAs) for Mobile Learning (m-learning) constitute a leading learning model for the next decade. M-learning allows learners to obtain learning materials anywhere and anytime using mobile technologies and the Internet (Ozdamli & Cavus, 2011). With the emergence of m-learning, the mobile learner will carry multiple heterogeneous wearable and

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handheld devices and he/she is able to continually learn wherever he/she is moving without any mobility, time and other restrictions (Economides, 2008). Consequently, the learner carries these portable devices to learn as well as to store the student model and the studied material (Lee et al., 2009). When coming with the mobile learning, the wide variety of technical characteristic and standards of devices (notebook computers, cellular phones, Personal Communication System (PCS), Personal Digital Assistants (PDAs)...) faces us to take into account new features in the adaption process: the device “preferences” (Chorfi, Sevkli, & Bousbahi, 2012). However, the unpredictable changing of the learner device at runtime influences the pedagogical efficiency of the Pedagogical Agents (PAs). It is the case when users move and the computing and the communication environment vary dynamically (Hallsteinsen Geihs, Paspallis, Eliassen, Horn, Lorenzo, & Papadopoulos, 2012). Accordingly, where execution conditions often change, adaptation at run-time is required in context-aware applications (Grondin, Bouraqui, & Vercouter, 2006). This forces the systems to self-adapt and improve their own behavior while trying to cope with such changes (Andrew, Viviane, & Carlos, 2009).

On the other side, the Self-adaptation seems a promising technique to implement self-adaptive pedagogical agents. The Self-adaptive software is a closed-loop system with a feedback loop aiming to adjust itself to changes during its operation. Such a system is required to monitor itself and its runtime context, detect significant changes, decide how to react, and act to execute such decisions (Salehie, & Tahvildari, 2009). In this perspective, context-aware systems, as a type of self-adaptive system, are able to adapt their operations to the current context without explicit user intervention and thus aim at increasing usability and effectiveness by taking environmental context into account (Baldauf, Dustdar, & Rosenberg, 2012). Context-aware adapting is an important requirement to keep the quality of the provided services at a high level. Since, it is imperative to expect that the software works as intended and that the software provides us with the largest possible utility always and everywhere. Thus, in the case of PA, they must be able not only to adapt the teaching to the student cognitive level and profile but also to ensure the pedagogical efficiency within unpredictable contexts. But, deciding what reactions a system has to a certain context is one of the hardest points in context-aware applications (Petrelli, Not, Zancanaro & Strapparava, 2001).

In fact, the FBGPA seems a suitable support to integrate the self-adapting capacity to PAs for m-learning. It is a component-based modeling of Pedagogical Agents that promotes the design and the building for reuse and by reuse of PAs. Reusability is the ability of software elements to serve for the construction of many different applications (Mayer, 1997). Also, the most interesting motivations behind the use of the FBGPA are its capacity to dynamically replace its internal sub-components and the clear separation of its internal structure from its fulfilling. Therefore, we propose a Context-Aware Self-Adaptive Fractal based Generalized Pedagogical Agent (CASA FBGPA) for m-learning that self-adapts to the unpredictable changing runtime context. In our case, to avoid the rules associated holes in carryout the self-adapting, we empower the PA by a distinct Search based Adapting Engine that dynamically monitors and assembles the appropriate linear combination of Fractal components. Through the Adapting Engine, the PA decides when and how to trigger its structural adaptation to the evolving runtime context. Also, to deal with the conflicting objectives and to reduce the substantial overhead, the component selection is formulated as a multiobjective problem and it is tackled using a metaheuristic search method. To evaluate the design and the feasibility of the proposed CASA FBGPA framework, a use case on the unpredictable changing of mobile devices and mobile device’s resources is presented and the results are discussed.

We discuss the proposition in the remainder of this paper in five sections. In the first one we will present the models used to design the FBGPA. We will continue with the presentation
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