Adaptive Learning as a Service – A concept to extend digital learning platforms?

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Abstract: Adaptive learning environments that adjust to the individual user are promising. Unfortunately, many digital learning environments are not yet adaptive and the transformation of legacy software to an adaptive learning environment is complex and costly. Our work introduces the concept of adaptive learning as a service and discusses potential benefits as well as challenges.

Keywords: Adaptive Learning, Microservice, Software-Architecture.

1 Overview

Adaptive learning environments offer a variety of benefits for their users. Based on data on users and user behavior, feedback, tasks, and task sequencing can be individualized [EM17]. Often, widely used existing learning environments are not yet adaptive, even though the high heterogeneity of users and the associated benefits of adaptivity have been known for a long time [Me19]. A new development of adaptive learning environments is often not feasible because of resource constraints. It is therefore plausible to extend and transform existing virtual learning environments (VLEs) by adding adaptive elements. However, working on legacy code - some of which is years old - is costly and error-prone. To solve this problem, we propose the concept of adaptive learning as a service.

2 Adaptive Learning as a Service

Adaptive learning as a service describes a concept, where an existing legacy online learning platform is transformed into an adaptive learning platform. To do this, the adaptive components, as well as adaptive interventions, are added as a microservice. This approach comes with several advantages. Existing platforms can continue to be used and the pedagogical and didactic expertise that has already flown into them is retained. The microservice can be developed and tested independently of the legacy platform and can be used by several platforms, i.e. they are transferable. Furthermore, the reduced complexity and the single responsibility principle leads to advantages in the adaptive

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learning field, as separate microservices can be created for each adaptation. For example, one service could be used for task sequencing, another for personalized feedback. That way, in a VLE, several adaptations can be switched on or off independently. The microservice is autonomous and can be deployed on a separate server, thus, underlying technologies are not dependent on the monolith.

Despite the many advantages, there are some limitations that need to be considered during development. To take advantage of the transferability of microservices to different platforms, standards for clickstream data or learning process data are needed. Furthermore, the microservice must be developed in close cooperation with domain experts in order to implement adaptations that make sense educationally. When implementing the interface in the existing platform, legacy code must be modified, as the monolith communicates with the microservice via an interface. The logic of the pipes must be as simple as possible, which means that the design of the interface and the microservice must be carefully planned. Furthermore, the database pattern has to be discussed. In the classic case, each microservice has its own database. This leads to data redundancy but is necessary for the decoupling of the services. However, in the case of transforming a digital learning platform into an adaptive learning platform with the help of microservices, we propose the shared database pattern as presented in [TLP18]. Here, all services and the monolith access the same database. This is especially useful if the learning process data is stored in the database and needs special data protection. Furthermore, if the microservice is to perform a certain prediction based on this data, inconsistencies would lead to incorrect adaptations. Also the deployment comes with special challenges. The microservices are deployed separately and a deployment strategy can be developed independently. However, the legacy platform has to have an deployment strategy as well. This can be more difficult, as continuous delivery could not be implemented yet and thus has to be developed.

In conclusion, the SaaS concepts widely used in software development provide great potential for virtual learning environments. Future work could include actual implementations, especially details on the work required in the legacy code and the entrypoint for adaptivity there, as well as how the concept can be transferred to widespread learning management systems (LMS) like Moodle and ILIAS.

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