Abstract

The goal of the following research proposal is to enable software systems to adapt towards user behavior and interaction patterns by providing a generally applicable architecture making use of physiological data. The proposed architecture mainly comprises a central reinforcement learning engine which uses few- or single-episode policy transfer to adapt to new users and domains as well as interconnected lightweight edge-cloud stream processing components for tailored preprocessing.

Innovations in machine learning, steam processing and new sensors to capture physiological data enable a fundamental change in user experience not only for consumer- but also of business-facing software systems. Making use of these new insights, software systems can truly focus on showing users the most suitable content as a result of the unfiltered feedback they get through physiological data. Collaborative filtering systems in online shops can be complemented by the physiological response users show towards products which can increase the conversion rate and consequently product sales. Furthermore, when interacting with business software, this offers the possibility to adjust the workload to the current cognitive load and state of attention of the individual user. This can improve productivity/decrease mistakes whilst increasing the joy of use.

Physiological data is sensitive health-related information and must therefore be processed securely and under strict rules and precautions (see GDPR[^1]). Furthermore, collecting physiological data in a streaming-fashion implies an increased amount of data to be processed and transferred over network, which must not increase the latency of the client or the software system. Current implementations mostly concentrate on single devices and use cases with predefined machine learning and stream processing steps. Hence an abstraction for different vendors, sensor types as well as towards different use cases and their requirements for data preprocessing should be ensured to guarantee general applicability.

Solution & Research Project Proposal

A collocation of interconnected lightweight edge-cloud stream processing components, which communicate in a determined fashion is proposed in order to pre-aggregate and adapt towards the use cases and the required data preprocessing. This reduces the data transferred over network since the computation is pushed to the edge and promotes secrecy as well as privacy since only condensed information is communicated (context information and interaction patterns) while taking into account to not overburden the commodity hardware on client-side.

A central reinforcement learning component implementing a single- or few-episode policy transfer[^8] is proposed to ensure fast adaption to different users and different domains (use cases) given only limited adaption time and few rewards. The reinforcement learning component is provided with the environment state S (result of processing physiological and application data), a reward R (provided by the application) and uses this to adjust the presented content (action A) which constitutes the overarching inherent feedback loop.

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[^1]: “Single Episode Policy Transfer in Reinforcement Learning”, Yang et. al., 2019, doi:10.3390/s19050989
[^2]: "Cognitive Load Theory", Sweller et. al., 2011, Springer
[^3]: "Health Data","https://www.euphobis-project.eu/work/platform/health", accessed last 24.01.2020