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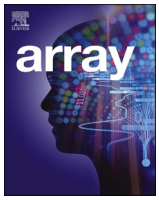

Special issue "Towards a higher education of the future: Transformational roles of edge intelligence"

Higher Education of the Future (HEF) is anticipated to be a scalable educational framework that is driven by new digital learning architectures and platforms, as well as collaborative learning systems, that are able to completely guarantee self-paced, customizable, personalized and flexible teaching/learning experiences [4]. The HEF concept strongly points toward a "learning from everywhere" model. The need for HEF is motivated, among other things, by the fact that most state-of-the-art higher education system models currently being used for driving and transitioning higher education are structurally, socially, and technologically incapacitated to meet the key requirements towards delivering a foreseeable smart, real-time intelligence driven HEF. The proliferation of edge devices, smart devices, intelligent applications, and Internet of Things in the higher education domain is now shifting the teaching/learning process, research, educational services, and data computation needs from the cloud to the network edge [5]. These edge devices and innovative digital technologies have potentials to exponentially drive seamless knowledge creation and increased learning. However, the massive volume of data being generated by these edge devices is currently becoming a challenge for cloud computing infrastructures in most HES to manage and analyse.

Cloud services can be moved from the network core to the edges via a distributed computing architecture through a distributed framework known as edge computing. This way, all enterprise applications and computation tasks are brought closer to the data sources, (for example, the local edge servers and edge devices) and the end-users. Edge is great and more secure than cloud in managing overloaded networks. Even in the situation of a cyber break-in, edge computing does not allow security disruption from a single node to spread and impact the activities of the entire network since its data is stored and processed locally. It can also allow for seamless and timely-efficient interactions between teachers and learners in virtual classrooms to effectively improve learning outcomes.

In a HEF concept, a valuable databank can be built within the network from a number of digital interactions of the devices in order to bring data closer to HEF' stakeholders, including the researcher, the learner or the administrators, who may require immediate access to it in real-time. In turn, as the data in the edge servers begins to aggregate, Artificial Intelligence (AI) is introduced to the edge for analytic purposes such that the edge device data is able to drive HEF-based AI applications via a concept known as edge intelligence. Edge intelligence (EI) is a promising and highly flexible technology evolving from some social and digital innovations with potentials to deliver a total digitally sustainable HEF that enhances learning experience. Among other things, EI can provide seamless real-time access to, and analytic insights of, the massive data generated by edge devices. This may include learning and prediction, of time-sensitive educational data to facilitate effective decision making or change needs. For example, evaluation of students' outcome while assessment is in progress. In a connected HEF, EI can help to support IoT capabilities, maximize bandwidth requirements and manage costs in a manner that teaching/learning effectiveness, continued independent learning.

This special issue provides an overview of the research being carried out in the higher education of the future focusing on transformational roles of edge intelligence methods and approaches for teaching, learning and entrepreneurship, as well as applications of them in the higher education sector.

To that end, the special issue brought together academics from a variety of disciplines to discuss the development and application of innovative edge intelligence-based solutions to effectively drive Higher Education of the Future. Original contributions in this field encompassed a wide spectrum of theoretical and practical aspects, technologies, and methods.

There are **three contributions** selected for this special issue, representing the use of the emerging technology progress and potential applications in the higher education of the future sector specifically addressed:

Edge-Intelligence based Learning Models: Edge-based learning models are an incredibly powerful technique that seamlessly integrates practical experience with the flexibility and accessibility of online learning [1]. The innovative model is specifically designed to be executed on an Edge Device, ensuring swift and highly efficient analysis. The remarkable findings of our study unequivocally demonstrate the exceptional success of the proposed method in empowering teachers to revolutionize their teaching methodologies, resulting in increased student engagement and enhanced learning outcomes. This technology that is based on the edge has provided students with greater convenience and flexibility in their academic pursuits. The task of measuring and evaluating the level of student engagement during online classes has proven to be particularly challenging. The system utilizes innovative technology to expedite and enhance the analysis of student attentiveness, ultimately resulting in improved learning outcomes and a more efficient learning process. The suggested model represents a noteworthy advancement in the progression of modern education as it equips teachers with a powerful technique.

Entrepreneurship education using modified ensemble machine learning model: Entrepreneurship education has become indispensable in recent times [2]. Participating in entrepreneurial training equips students with the necessary skills to enhance their capacity to develop

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marketable and profitable solutions to emerging challenges. To achieve this, numerous aspiring entrepreneurs rely on technology to engage in entrepreneurship education. The proposed framework exhibited a notable accuracy rate and confirmed the capability of machine learning techniques in forecasting students' adjustment to entrepreneurship education and training. The proposed modified model of ensemble machine learning has the capacity to assist the key actors of the institutions in the identification of students who may necessitate additional support. Moreover, it can contribute to the personalization of pedagogical approaches and the formulation of focused measures to augment the flexibility and overall educational encounter of individuals within the domain of entrepreneurship instruction. The outcomes of the research study reveal that all students have achieved a high level of satisfaction in meeting the objectives of the course. However, it is noteworthy that students who attended the course in a traditional classroom setting reported a greater sense of accomplishment compared to those who took the course online. In order to further augment students' learning outcomes, it is recommended that the online course incorporates pedagogical activities that necessitate active learning. As a result, this research investigation constitutes a significant addition to the growing reservoir of information pertaining to the application of technology in the realm of entrepreneurial endeavours.

Affective state prediction of learning: The investigation of the emotional state of a learner in higher education has garnered significant attention. The inclusion of designated mediation can improve learning outcomes by predicting the learner's affective state [3]. The innovative algorithm exhibits superior performance compared to other methods, demonstrating the highest prediction accuracy and the most notable correlation, respectively. Upon discovering affective states, students can benefit from receiving authentic feedback from teachers to enhance their learning performance. This research proposes a methodology for predicting affective states. Initially, the experimental study utilizes three for various courses. These courses can be categorized as High complexity subjects, medium complexity subjects, and Low complexity subjects. Various learners study these courses using a Learning Management System (LMS), which generates a log file based on their learning patterns. Subsequently, the extracted features are employed for predicting the affective states of the learners. The developed model demonstrates stability across different levels of course complexity. It proves to be valuable for various applications, including course recommendation systems, identification of at-risk students, enhancement of online course quality, and monitoring of learners' progress and performance.

Declaration of competing interest

The authors assert that they possess no identifiable conflicting financial concerns or interpersonal connections that may have seemed to exert an impact on the research findings presented in this manuscript.

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