Research Statement

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Background

Put broadly, my research interests are mainly on the application of technological tools and techniques e.g. Artificial Intelligence (AI) and Machine Learning (ML) in enhancing Teaching and Learning (T&L). My PhD research is on the development of an Affective Tutoring System (ATS) which senses the learner's affect on a moment by moment basis with the use of unobtrusive sensors. The ATS senses academic emotions e.g. boredom and frustration of the learner and adapts its tutoring response dynamically. This research crosses multiple disciplines, namely education, psychology and AI. In this research, I have used the technique of sentic modulation (Picard 1997) or the physical assessment of a person's affective states through sensors for affect sensing. The translation of the sensed affect into the tutoring strategies is in turn underpinned by education and psychological theories.

My recent research interests are more varied but are still rooted in the area of using technology to elucidate T&L. I am currently working on analysis and visualization of educational activity logs captured by educational technology tools such as digital whiteboards. The analysis of these logs allows educators to uncover the process of collaborative work and problem-solving behaviors of students, offering an alternative lens into assessment and evaluation of students' group project work.

Other than education, I am also working on consultancy work for application of AI in other industrial applications. One of these is in the area of agricultural regulatory compliance where I apply deep learning and computer vision techniques to capture and translate regulatory documents in graphical formats into important text required for regulatory compliance.

Research Areas

Multimodal Affect Detection

Most previous studies on the use of sentic modulation have used a single sensor (unimodal) for affect sensing. Humans, on the other hand express our affect in multiple channels e.g. facial expressions, body postures and vocal intonations which thus leads to the belief that the use of multiple modalities for affect detection would more closely emulate human affect expression. Multimodal affect sensing is hypothesized to be superior to unimodal affect sensing as it is commonly believed that the multiple sensors complement one another. It also offers the affordance of data missing in some of the modalities as other modalities can make up for the missing data albeit at a degraded performance.

As compared to unimodal affect detection, the use of multiple modalities involves more technical complexities and issues. Baltrušaitis, Ahuja et al. (2018) aptly summarizes the technicalities of multimodal affect detection into the 5 categories – Representation, Translation, Alignment, Fusion and Co-learning. Representation refers to the representation of heterogeneous multimodal data for the exploitation of complementarity and redundancies in multiple modalities. Translation refers to the mapping of data from one modality to another. Alignment refers to the identification of relations between elements from two or more modalities. Fusion refers to the joining of information from the modalities to perform a prediction while Co-learning relates to how knowledge learned on one modality can be transferred to a computational model trained on another modality.

Multimodal affect detection is still an area of active research owing to the fact that emotion is elusive and expressions of emotions are multimodal and varies according to the context i.e. people behave differently in different social contexts. The growing acceptance, use and standardization of wearables for physiological measurements and the promise of deep learning and other AI techniques offer potential for further improvement in accuracy of multimodal affect detection.

Mining educational activity logs

Collaboration is an essential skill for the 21st century workforce. In the modern classroom, collaborative learning, an educational approach which involves learners working together in small teams towards a common goal, is posited to lead to enhanced learning outcomes as compared to didactic instruction. In contrast to didactic instruction where learners receive knowledge passively from the teacher, collaborative learning is an active learning approach where learners participate actively with each other and co-construct their knowledge in the process.

Some of the challenges associated with collaborative learning relates to that of individual effort attribution. Social loafing (reduction of personal effort when working in a group) and free-riding (individual bearing minimum work but sharing benefits of the group) are some undesirable side-effects of collaborative learning but yet they are difficult to detect and prevent. Assessing only the outcome or final artifact but not the process is another issue which resulted in groups taking the safe and tested instead of some unorthodox and innovative means of solving the allocated tasks. By mining educational activity logs captured by modern educational technological tools e.g. digital whiteboard, I hope to uncover the process that learners took in resolving the problem and to distill evidences of social-loafing and free-riding.

LLMs for re-designing pedagogy

On another related research, I intend to harness Large Language Models (LLMs) to elucidate the learning misconceptions of students targeting at the learning of computer programming and related concepts e.g. writing of software test cases. LLMs has seen unprecedented research interest for its use in many application areas. Within computing programming, there were many studies investigating the use of LLMs for automatic program repair, code summarization and program generation. These would have repercussions on computer programming pedagogy and offer tremendous opportunities for reimagining information systems pedagogy. One strand of research that I would like to undertake is to uncover programming misconceptions of students from their program output e.g. from exercises or assessments. The automatic mining and collating of these programming errors would then offer instructors an automated way of uncovering the top misconceptions of their students. In a similar fashion, the natural language processing and knowledge representation capabilities of LLMs can be possibly exploited for educating students on the writing of adequate test cases and programs from the requirements specifications.

(Please take the time to describe your interests and ideas in intellectually stimulating and interesting ways. Do not just rely on a list of paper titles to convey what is interesting and exciting. Write your statement in a way that highlights interesting questions, ways of pursuing these questions, and the types of insights you are accumulating.)

Selected Publications and Outputs

- Investigating collaborative problem solving temporal dynamics using interactions within a digital whiteboard, International Conference on Computer Supported Education (CSEDU), 2023
- Unveiling the process of collaborative learning through the use of digital whiteboard historical action logs, International Conference on Computers in Education (ICCE), 2022
- Deep Learning-based text recognition of agricultural regulatory document, International Conference on Computational Collective Intelligence (ICCCI), 2022
- Fine-grained detection of academic emotions with spatial temporal graph attention networks using facial landmarks, International Conference on Computer Supported Education (CSEDU), 2022
- Enhancing Project Based Learning with Unsupervised Learning of Project Reflections, International Conference of Digital Technology in Education (ICDTE), 2021
- An architectural design and evaluation of an affective tutoring system for novice programmers, International Journal of Educational Technology in Higher Education, 2018