INVITED TALKS

(abstracts)
ABSTRACT

With over 100 million users, Duolingo is the most popular education app in the world in Android and iOS. In the first part of this talk, we will describe the motivation for creating Duolingo, its philosophy, and some of the basic techniques used to successfully teach languages and keep users engaged. The second part will focus on the machine learning and natural language processing algorithms we use to model student learning.
Personal Knowledge/Learning Graph

ABSTRACT
Educational data mining and learning analytics have to date largely focused on specific research questions that provide insight into granular interactions. These insights have been abstracted to include the development of predictive models, intelligent tutors, and adaptive learning. While there are several domains where holistic or systems models have provided additional explanatory power, work around learning has not created holistic models with the level of concreteness or richness required. The need for both granular and integrated high-level view of learning is further influenced by distributed, life long, multi-spaced learning that today defines education. Drawing on social and knowledge graph theory, we propose the development of a Personal Knowledge/Learning Graph (PKLG) - an open and learner-owned profile that addresses cognitive, affective, and related elements that reflect what a learner knows, is able to do, and processes through which she learns best. This talk will introduce PKLG, detail required technical infrastructure, and articulate how it would interact with established learning software.
ABSTRACT

Becoming numerate is considered as one of the fundamental skills needed in the modern technology-driven society. The latest OECD (2013) report states that "The way we live and work has changed profoundly and so has the set of skills we need to participate fully in and benefit from our hyper-connected societies and increasingly knowledge-based economies. The societies invest a lot on education with varying results. For some reasons there still are persons do not reach even a basic level of skills in numeracy or literacy irrespective of the recent advances in education, educational research and educational technologies.

Persons who fail in learning numeracy, even though they have had an opportunity to learn and who, based on their other skills, should have learnt, we call as having specific learning disabilities (SLD), developmental dyscalculia (DD). This discrepancy between learning opportunities, general skills and poor performance in mathematics, has intrigued researchers now more than a century. From the early beginning of the research there has been ideas that it has something to do how the brain of these persons have organized, failed to develop or damaged.

The recent developments in research methodologies, especially in brain imaging and statistical technologies, have opened new windows to analyze these brain related hypotheses. In my presentation I will open some of these windows with examples from functional brain imaging to longitudinal studies based on multivariate statistical analysis.

The new windows show different views from the DD. From one perspective the DD looks like a unitary construct with very specific symptoms in numerical processing. This view has been more typical within the brain imaging research. The other views show a complex where myriad of factors from genetic to learning experiences each contribute with a small share to the large variation of the individual skills. This view has been more typical in behavioural and cognitive studies, especially in longitudinal research. Whether a common ground can be reached, and what it needed for that, is discussed.

References


INVITED PANELS

(abstracts)
Industry Panel: The Future of Practical Applications of EDM at Scale

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ABSTRACT
This mixed panel of different professionals working in EDM will be a conversation about increasing the connection between research and real-world applications. What’s going on now to scale techniques for use "out there" in the field? What should researchers, funders, regulators, publishers, trainers, schools/universities and others be doing to get ready for practical work? What’s in the way that we can usefully start work to address? We’ll ask the audience to engage in this conversation as well - what’s in your way to moving work from research environments to practically help learners at scale - and to generate more usable data at scale?
Ethics and Privacy in EDM

ABSTRACT
Educational data mining is inherently falls into the category of the so-called secondary data analysis. It is common that data that have been collected for administrative or some other purposes at some point is considered as valuable for other (research) purpose. Collection of the student generated, student behavior and student performance related data on a massive scale in MOOCs, ITSs, LMS and other learning platforms raises various ethical and privacy concerns among researches, policy makers and the general public. This panel is aimed to discuss major challenges in ethics and privacy in EDM and how they are addressed now or should be addressed in the future to prevent any possible harm to the learners. Several experts are invited to discuss the potential and challenges of privacy-preserving EDM, ethics-aware predictive learning analytics, and availability of public benchmark datasets for EDM among others.
Grand Challenges for EDM and Related Research Areas

ABSTRACT
Educational data mining (EDM) and Learning analytics are still rather young research areas. The goal of this panel is to share different views on what major challenges researches need to address in EDM, learning analytics and related research areas including but not limited to User modeling, AI in Education, and Learning Sciences. The representatives of the corresponding communities are invited to discuss what grand challenges we should aim to address for the next five years, and which of these challenges are old and which are new, which of them peculiar to one distinct research area and which of them are shared across two or more research areas.
JEDM TRACK PAPERS

(abstracts)
Metrics for Evaluation of Student Models

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ABSTRACT
Researchers use many different metrics for evaluation of performance of student models. The aim of this paper is to provide an overview of commonly used metrics, to discuss properties, advantages, and disadvantages of different metrics, to summarize current practice in educational data mining, and to provide guidance for evaluation of student models. In the discussion we mention the relation of metrics to parameter fitting, the impact of student models on student practice (over-practice, under-practice), and point out connections to related work on evaluation of probability forecasters in other domains. We also provide an empirical comparison of metrics. One of the conclusion of the paper is that some commonly used metrics should not be used (MAE) or should be used more critically (AUC).
We present an approach to Intelligent Tutoring Systems which adaptively personalizes sequences of learning activities to maximize skills acquired by students, taking into account the limited time and motivational resources. At a given point in time, the system proposes to the students the activity which makes them progress faster. We introduce two algorithms that rely on the empirical estimation of the learning progress, RiARiT that uses information about the difficulty of each exercise and ZPDES that uses much less knowledge about the problem.

The system is based on the combination of three approaches. First, it leverages recent models of intrinsically motivated learning by transposing them to active teaching, relying on empirical estimation of learning progress provided by specific activities to particular students. Second, it uses state-of-the-art Multi-Arm Bandit (MAB) techniques to efficiently manage the exploration/exploitation challenge of this optimization process. Third, it leverages expert knowledge to constrain and bootstrap initial exploration of the MAB, while requiring only coarse guidance information of the expert and allowing the system to deal with didactic gaps in its knowledge. The system is evaluated in a scenario where 7–8 year old schoolchildren learn how to decompose numbers while manipulating money. Systematic experiments are presented with simulated students, followed by results of a user study across a population of 400 school children.
ABSTRACT

Interactive learning environments can provide learners with opportunities to explore rich, real-world problem spaces, but the nature of these problem spaces can make assessing learner progress difficult. Such assessment can be useful for providing formative and summative feedback to the learners, to educators, and to the designers of the environments. This work adds to a growing body of research that is applying EDM techniques to more open-ended problem spaces.

The open-ended problem space under study here is an environmental science simulation. Learners were confronted with the real-world challenge of effectively placing green infrastructure in an urban neighborhood to reduce surface flooding. Learners could try out different spatial arrangements of green infrastructure and use the simulation to test each solution’s impact on flooding. The learners’ solutions and the solutions’ performances were logged during a controlled experiment with different user interface designs for the simulation. As with many open-problem spaces, analyzing this data was difficult due to the large state space, many good solutions, and many alternate paths to those good solutions.

This work proposes a procedure for reducing the state space of solutions defined by spatial patterns while maintaining their critical spatial properties. Spatial reasoning problems are a problem class not yet examined by EDM, so this work sets the stage for further research in this area. This work also details a procedure for discovering effective spatial strategies and solution paths, and demonstrates how this information can be used to give formative feedback to the designers of the interactive learning environment.
ABSTRACT

In educational technology and learning sciences, there are multiple uses for a predictive model of whether a student will perform a task correctly or not. For example, an intelligent tutoring system may use such a model to estimate whether or not a student has mastered a skill. We analyze the significance of data recency in making such predictions, i.e., asking whether relatively more recent observations of a student’s performance matter more than relatively older observations. We investigate several representations of recency, such as the count of prior practice in the AFM model, and the proportion of recent successes with exponential and box kernels. We find that an exponential decay of a proportion of successes provides the summary of recent practice with the highest predictive accuracy over alternative models. As a secondary contribution, we develop a new logistic regression model, Recent-Performance Factors Analysis, that leverages this representation of recent performance, and has higher predictive accuracy than existing logistic regression models.