Expanding Adaptive Algorithms in New Ways: Echo-Adapt Software-As-A-Service

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**ABSTRACT:** High-quality assessment platforms rely on appropriate content and reliable statistical models to estimate the examinee’s ability efficiently. The assessment content must represent the knowledge, skills, and abilities of interest. Statistical models need to accommodate differences between items, e.g., some are more difficult than others. Further, it is important to understand the probability of a response given both the examinee’s ability and characteristics of the item. Practically, additional requirements include: 1) Low latency for user experience, 2) Interoperability with test drivers, 3) Simple ways to apply statistical models to new content (aka “field testing”), 4) Ways to control the exposure of content, and 5) Levels of adaptivity. A well-known approach within psychometrics is the shadow-test approach (van der Linden, 2005), which allows for the simultaneous management of many of these aspects. In this session, we will provide background on this approach and include a demonstration of RSCAT, an open-source R package solution available to researchers using the approach. We will also briefly demonstrate Echo-Adapt®, software-as-a-service built to deliver...
Predicting student knowledge at scale at Duolingo

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ABSTRACT: One of the central promises of computerized instruction is the personalization of learning. A prerequisite to fully realizing this promise is making high quality inferences about a learner’s current knowledge state, in order to optimize what material is most useful to present next. Here, we describe recent progress in solving this problem at scale at Duolingo, a language learning platform with over 300 million users worldwide spread across over 80 separate language courses. We focus on two instantiations of this general problem: (1) how to rapidly assess the overall knowledge level of a new user who is starting Duolingo already having substantial experience with the language and (2) how to estimate the details of what an existing Duolingo user knows from their history of interactions with the platform. In both of these case studies, solving the problem at scale adds additional complexity and limitations on possible solutions. However, working at scale also enables the possibility of leveraging a large amount of learning data from other users to improve inferences. We present techniques taking advantage of this data by combining machine learning with classical models from psychometrics and cognitive science, to yield state-of-the-art inferences about user knowledge state.

TutorGen SCALE® – Student Centered Adaptive Learning Engine

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ABSTRACT: TutorGen’s Student Centered Adaptive Learning Engine (SCALE®) represents a breakthrough in developing adaptive educational systems by using big data collected from new or existing educational software systems to automatically generate intelligent tutoring capabilities. This work aims to make adaptive learning widely available; to give students real-time, useful feedback; and to provide tools to teachers for assessing student performance. SCALE does this by collecting student data from new or existing digital learning systems and then automatically generating adaptive capabilities based on this data. In this way SCALE is able to efficiently turn any edtech product into an intelligent tutoring system, with very little need for new software customization or expensive and time-intensive manual input. Adaptive learning has long been proven to decrease time to learn and increase retention and understanding for students, but has not been widely adopted due to the high cost of implementation. SCALE solves this challenge with a human-centered, data-driven approach by using Artificial Intelligence and machine learning techniques to generate adaptability in a way that is content and system agnostic. Here we report on our approach for creating and implementing SCALE, and the refinements created to bring this technology from the research lab into the classroom.

The ASSISTments TestBed: Opportunities and Challenges of Experimentation in Online Learning Platforms

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ABSTRACT: The ASSISTments TestBed is a platform for conducting small-scale, short term randomized trials within the ASSISTments online learning platform. Any education researcher may propose an experiment, which will be run at no cost. As a learning system, ASSISTments is positioned to augment teacher instruction and help students learn. As a shared scientific instrument, the system aims to facilitate the running of studies to learn what types of instructional strategies and content helps which students most and openly share such information and tools to benefit educational research. Through the exploration and analysis of 9 experiments run within ASSISTments, we describe how these tools are being combined with multiple methods to better identify what works for whom. Toward the goal of more precisely measuring treatment effects, this paper acts as an overview of some of the scientific and statistical opportunities that the TestBed system affords when compared to traditional randomized trials in education. We will argue that this framework represents a promising, if uncharted, avenue in the science of education, and merits the attention of both methodologists and substantive education researchers.
**Instrumenting Courseware and Leveraging Data with the Open Learning Initiative (OLI)**

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**ABSTRACT:** Founded in 2002 as part of the Hewlett Foundation’s inaugural open education grants, the Open Learning Initiative (OLI) is a recognized leader in adaptive courseware and learning engineering, combining leading research in cognitive and learning science with state-of-the-art technology to create adaptive, open courseware that enacts instruction. By rigorously capturing and evaluating learner data, OLI drives powerful feedback loops that assist learners, support educators, improve courses, and drive learning science research. This workshop will provide an overview of creating instrumented courseware with OLI’s tools, aligning measurable, student-centered learning outcomes with active learning activities and assessments. We will provide examples of the data generated by OLI learner interactions and show how this data is used to provide feedback to learners and drive analytics for both instruction and course improvement. Finally, we will show how OLI data is made available for research, teaching participants how to access this information and providing examples of how this data has been used to support primary research, secondary analysis, and ongoing analytics work. Participants will leave with the ability to build their own OLI courses, the ability to access OLI data for their own work, and contacts for ongoing engagement with the OLI team.

**LearnSphere: Learning Analytics Development and Sharing Made Easy**

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**ABSTRACT:** LearnSphere.org provides a web-based learning analytics authoring environment where non-programmers can build, share, and modify novel combinations of a rich and growing set of methods. Methods for data import, transformation, statistical analysis, machine learning inference, and visualization and reporting can be combined in novel workflows. These workflows are linked to data and both workflow analytics and data can be shared and modified. A wide variety of workflows exist corresponding with techniques used a wide variety of published analytics.

**AskOski: Using University Enrollment Data to Surface Novel Semantic Structure and Personalized Guidance**

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**ABSTRACT:** This paper presents ways in which the synthesis of data from higher-ed can illuminate the terrain of the university and support students in their decision making and wayfinding. A novel application of recurrent neural networks and skip-grams, techniques popularized by their application to modeling language, are brought to bear on millions of historic student course enrollments to create vector representations of these objects. Analysis of the produced vector space reveals predictive information about students' on-time graduation and a high degree of emergent semantic relational information about courses which can be visualized, reasoned about, and surfaced to students. A course information platform, adopted by the UC Berkeley Office of the Registrar, uses this automatically inferred semantic information to help students navigate the university's offerings and provides personalized course suggestions based on topic preference, course history, and program requirements. Considerations for scaling such a system across the system will be discussed, as well as its place in the multi-stakeholder environment of the university.

**Enhancing Test Preparation via Continuous Tracking of Practice Assessment Analytics &Personalized Resource Recommendations**

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ABSTRACT: Learners preparing to take summative, high-stakes assessments such as The ACT College Readiness Assessment will typically use resources to review the knowledge and skills that are associated with the requisite academic subjects. Given the broad scope of these subject domains, learners would benefit by receiving targeted, personalized lists of recommended resources that align with their individually diagnosed area needs. In our work, we have created a Recommendations and Diagnostics (RAD) API that can be plugged into a learning and assessment system to continuously track a learner’s practice assessment analytics and translate that into predictions of skill mastery. Using these predictions, we drive a recommendation engine that prioritizes areas of need based on ACT’s Holistic Framework and delivers sets of tagged open educational resources for learners to review. We discuss our hierarchical skills-based variation on the use of Elo ratings as well as the role of industry standards such as IMS Global Caliper and the Competency & Academics Standards Exchange (CASE) as part of our initial integration into ACT’s free test preparation solution.

Conceptual Change as Evidence of Learning

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ABSTRACT: Extending prior work on knowledge component modeling via segmented learning curves, we consider properties of such learning curves that seem to indicate how heterogeneous populations of students learn over time. Pointing to the possibility that different cognitive models may be appropriate for different student populations, we use a concrete example and evidence from an initial pilot study to illustrate how conceptual change may provide evidence for learning.
The Effects of Adaptive Learning in a Massive Open Online Course on Learners’ Skill Development

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ABSTRACT: We report an experimental implementation of adaptive learning functionality in a self-paced Microsoft MOOC (massive open online course) on edX. In a personalized adaptive system, the learner’s progress toward clearly defined goals is continually assessed, the assessment occurs when a student is ready to demonstrate competency, and supporting materials are tailored to the needs of each learner. Despite the promise of adaptive personalized learning, there is a lack of evidence-based instructional design, transparency in many of the models and algorithms used to provide adaptive technology or a framework for rapid experimentation with different models. ALOSI (Adaptive Learning Open Source Initiative) provides open source adaptive learning technology and a common framework to measure learning gains and learner behavior. This study explored the effects of two different strategies for adaptive learning and assessment: Learners were randomly assigned to three groups. In the first adaptive group ALOSI prioritized a strategy of remediation – serving learners items on topics with the least evidence of mastery; in the second adaptive group ALOSI prioritized a strategy of continuity – that is learners would be more likely served items on similar topic in a sequence until mastery is demonstrated. The control group followed the pathways of the course as set out by the instructional designer, with no adaptive algorithms. We found that the implemented adaptivity in assessment, with emphasis on remediation is associated with
a substantial increase in learning gains, while producing no big effect on the drop-out. Further research is needed to confirm these

Kidaptive’s Journey Towards a Scalable Learning Analytics Solution

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ABSTRACT: Since its founding in 2011, Kidaptive has built customized models that provide adaptivity and/or personalization in online learning environments. We began by enabling adaptive game-based learning through rule-based and then dynamic Bayesian psychometric models. Driven by strong demand, we also started developing models of learner behavior in more traditional online learning and online test preparation environments, based on learners’ time management, answer behavior and test scores. These models produce personalized insights for learners and teachers to promote more effective study behavior. Because building a custom solution for every learning environment is not scalable, we have recently been working toward an abstracted version of the models we have built so far, which can be provided as an “out-of-the-box” product offering. One hurdle when onboarding new customers is getting their data into a form that is suitable for the types of (psychometric or behavioral) modeling we offer. Our new product provides a set of customer guidelines for mapping content to learning dimensions or skills and for sending learner responses, response times, and activity data as time-stamped events. Given those data, we provide a set of basic insights about learners’ strengths and weaknesses, as well as the time learners take to answer questions and complete tests. Our next goal is to identify under which conditions the more interesting psychometric and behavioral models we developed for previous customers are feasible and valid, and to offer those models to new customers whenever those conditions are met. As we continue to build custom models for customers, we will also expand the set of models we can offer in our out-of-the-box product. This paper will cover some of the models we have successfully implemented (as well as lessons learned in the process), the current status of our self-service product, and some initial explorations of conditions for advanced model offering.
PERSEUS – a Personalization Services Engine for Online Learning

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ABSTRACT: PERSEUS – a Personalization Service Engine – first launched almost a decade ago in 2009 as an attempt to promote the reuse of a suite of adaptation and personalization techniques previously piloted as separate "shell" apps providing adaptive access to educational resources. The design of PERSEUS targeted the ease of development and deployment of personalization and adaptation services in a generic Learning Management System. Since its first deployment, PERSEUS has been used in a several dozens of unique courses and nearly a hundred course offerings. PERSEUS features several classes of services supporting skill-based student knowledge tracking, topic-based modeling, and social navigation. It relies on an external user modeling server that supplies various forms of student activity statistics. PERSEUS requires the linear map of a learning space being personalized and outputs a personalized version of the map. Personalization could be in the form of modifying the elements of the learning space (adding, removing, reordering) or annotating the space and adding interactive elements to it.