# ADITI KRISHNA MALLAVARAPU

https://aditimallavarapu.github.io/aditi-portfolio/#/


Learning Sciences and Technology Post-Doctoral Researcher
Center for Integrative Research in Computing and Learning Sciences (CIRCLS),
Digital Promise Global San Francisco, CA
amallavarapu@digitalpromise.org

Artificial Intelligence in Education Visiting Researcher and Scholar
School of Computing and Information
Learning Research & Development Center
University of Pittsburgh, Pittsburgh, PA
aditimal@pitt.edu


## RESEARCH INTERESTS

Artificial Intelligence for Education, Machine Learning and Data Mining on Educational Data (including Educational Data Mining, Learning Analytics, Data Visualization)
Human-Computer Interaction applied towards designing intelligent aides for Complex System
Designing intelligent solutions for Social Educational Environments (e.g., Museums, science centers)
Learning in Immersive, Virtual Reality, and Mixed Reality Environments

## EDUCATION

| | | | | |
|---|---|---|---|---|
| Aug 2016 | – | Dec 2021 | **PhD** | **Computer Science**<br>Human-Computer Interaction, Learning Analytics, Educational Data Mining and Learning Sciences Concentration<br>Advisor: Leilah Lyons<br>University of Illinois at Chicago (UIC), Chicago, IL, USA<br>PhD Thesis Title: *Formative fugues: Conceptualizing data-driven formative feedback for open-ended learning environments* |
| Aug 2012 | – | Oct 2014 | **MS** | **Computer Science**<br>Educational Data Mining Concentration<br>Advisor: Leilah Lyons<br>University of Illinois at Chicago (UIC), Chicago, IL, USA<br>MS Thesis Title: *Developing Computational Methods to Measure and Track Learner's Spatial Reasoning* |
| Aug 2007 | – | May 2011 | **BE** | **Computer Engineering**<br>University of Pune, India |

## RESEARCH EXPERIENCE

| | |
|---|---|
| Jul 2021 - Present | **Learning Sciences and Technology Post-Doctoral Researcher**<br>Center for Integrative Research in Computing and Learning Sciences (CIRCLS)<br>Mentor: Jeremy Roschelle<br>Digital Promise, San Francisco, CA |
| Jul 2021 - Present | **Artificial Intelligence in Education Visiting Researcher and Scholar**<br>School of Computing and Information<br>Learning Research & Development Center<br>Mentor: Erin Walker, Rosta Fazan<br>University of Pittsburgh, Pittsburgh, PA |

| | |
|---|---|
| Dec 2020 - Jan 2021 | **Digital Learning Data Mining and Visualization Research Assistant** |
| May 2020 - Aug 2020 | Digital Learning |
| Dec 2019 - Jan 2020 | Mentors: Leilah Lyons & Stephen Uzzo |
| Jun 2019 - Aug 2019 | New York Hall of Science, Queens, NY |
| Jul 2017 - Aug 2017 | |

## TEACHING EXPERIENCE

| | |
|---|---|
| Jan 2018 - May 2021 | **Graduate Teaching Assistant,** Programming Design II (CS 141), Dale Reed, Joe Hummel, University of Illinois at Chicago, Chicago, IL |
| Jun 2018 - Aug 2018 | **Adjunct Professor,** Discovering Computer Science (CS 100), University of Illinois at Chicago, UIC Chance, Chicago, IL (Class size: 30) |
| Jan 2018 - Apr 2018 | **Instructor,** Computer Science Elective: Discovering Computer Science (CS 100), University of Illinois at Chicago, Saturday College UIC Chance, Chicago, IL (Class size: 30) |
| Jan 2017 - Dec 2017 | **Graduate Teaching Assistant,** Discovering Computer Science (CS 100), Dale Reed, University of Illinois at Chicago, Chicago, IL |
| Aug 2016 - Dec 2016 | **Graduate Teaching Assistant,** Discrete Mathematics (CS 151), Bhaskar Dasgupta, University of Illinois at Chicago, Chicago, IL |

## PUBLICATIONS

### Book Chapters

Beheshti, E., Lyons, L., **Mallavarapu, A.,** Thompson, W., Wallingford, B., & Uzzo, S. (2021). Co-designing Learning Dashboards for Informal Educators in H. Ba, K. McMillan Culp, and M. Honey (Eds.), *Design Make Play for Equity, Inclusion, and Agency*, Routledge.

### Journals

#### *Published*

**Mallavarapu, A.,** Lyons, L., & Uzzo, S. (2022). Exploring the Utility of Social-Network-Derived Collaborative Opportunity Temperature Readings for Informing Design and Research of Large-Group Immersive Learning Environments. *Journal of Learning Analytics*, *9*(1), 53–76. https://doi.org/10.18608/jla.2022.7419

**Mallavarapu, A.,** Uzzo, S., & Lyons, L. (2021). Formative Fugues: Reconceptualizing Formative Feedback for Complex Systems Learning Environments. International Journal of Complexity in Education, 2(2), 4–46.

Lyons, L., & **Mallavarapu, A.** (2021). Collective Usability: Using Simulation Tools to Explore Embodied Design Challenges in Immersive, Shared Mixed-Reality Experiences. Journal of Educational Technology & Society, 24(2).

**Mallavarapu, A.**, Lyons, L., Slattery, B., Shelley, T., Minor, E., & Zellner, M. (2015) Developing Computational Methods to Measure and Track Learners' Spatial Reasoning in an Open-Ended Simulation. *Journal of Educational Data Mining 7*(2), 49-82.

#### *In preparation*

**Mallavarapu, A.**, Lyons, L., Uzzo, S., "Formative Fugues": A Novel Exploration Support Conceptualization for Collaborative Open-Ended Learning Environments. *To be submitted to the International Journal of Computer Supported Collaborative Learning.*

**Mallavarapu, A.**, Lyons, L., Zheleva, E., Uzzo, S., Causal Modeling of Open-Ended Learning Environments for Generating Formative Feedback. *To be submitted to the Journal of Learning Analytics.*

**Reviewed Conference Papers, Full**

***Published***

**Mallavarapu, A**., Lyons, L., Uzzo, S., Thompson, W., Levy-Cohen, R., & Slattery, B. (2019). Connect-to-Connected Worlds: Piloting a Mobile, Data-Driven Reflection Tool for an Open-Ended Simulation at a Museum. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (pp. 1-14). ACM Press.

**Reviewed Conference Papers, Short**

***Published***

Risha, Z., **Mallavarapu, A.,** Rosta, F., Jaime, B., Dondal, B., & Walker, E. (2022). Proposing a Role-Based Framework for Data Literacy. In Chinn, C., Tan, E., Chan, C.,& Kali, Y.(Eds.). Proceedings of the 16th International Conference of the Learning Sciences ICLS 2022. Hiroshima, Japan: International Society of the Learning Sciences.

Levy-Cohen, R., **Mallavarapu, A.,** Lyons, L., & Uzzo, S. (2021). Studying Shared Regulation in Immersive Learning Environments. In C. Hmelo-Silver, B. de Wever, & J. Oshima (Eds.). Proceedings of 15th International Conference on Computer-Supported Collaborative Learning – CSCL 2021 (pp. 100–115). International Society of the Learning Sciences.

**Mallavarapu, A.,** & Lyons, L. (2020) Exploration Maps, Beyond Top Scores: Designing Formative Feedback for Open-Ended Problems. In Proceedings of the International Conference on Educational Data Mining (EDM) (6 pages).

Beheshti, E., Lyons, L., **Mallavarapu, A.,** Wallingford, B., & Uzzo, S. (2020, April). Design Considerations for Data-Driven Dashboards: Supporting Facilitation Tasks for Open-Ended Learning. In Extended Abstracts of the 2020 CHI Conference on Human Factors in Computing Systems (pp. 1-9).

**Reviewed Conference Abstracts**

***Published***

Levy-Cohen, R., **Mallavarapu, A.,** Lyons, L., Uzzo, M, S. (April, 2021). Studying collective problem-solving regulation in an immersive open-ended museum exhibit American Educational Research Association (AERA) Annual Meeting.

Beheshti, E., Lyons, L., Thompson, W., **Mallavarapu, A.** & Uzzo, S. M. (2020, Apr 17 - 21) Human-in-the-Loop: Supporting Facilitators' Scaffolding of Visitor Engagement and Learning in Science Museums [Roundtable Session]. AERA Annual Meeting San Francisco, CA

## HONORS AND AWARDS

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|---|---|
| Jun 2022 | 1000$, Travel scholarship awarded participating in Consortium of Science of Socio-Technical Systems (CSST), Austin, TX |
| Feb 2022 | Recognized as Emerging Scholar in Research by CIRCLS team |
| Nov 2020 | 500$, Awarded Scholarship to attend the CRA-WP virtual mentorship workshop (Online) |
| Jun 2019 | 500$, 2018-2019 Best Teaching Assistant Award, Computer Science, University of Illinois at Chicago, IL |

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|---|---|
| Mar 2019 | 1800$, ACM SIGCHI student travel grant to attend the ACM SIGCHI 2019 in Glasgow, UK |
| Jan 2018 | 2000$, UIC Chance Program Scholarship, University of Illinois at Chicago, IL |
| Aug 2016 & Jan 2017 | 5000$, Peter and Deborah Wexler Graduate Student Award Scholarship, University of Illinois at Chicago, IL |
| Jun 2015 | Conference paper selected to become journal article, International Conference of Educational Data Mining, Madrid, Spain |
| Jun 2015 | 1500$, Professor Ram Kumar Scholarship to attend the International Conference of Educational Data Mining Madrid, Spain |
| Apr 2015 | 1000$, Computer Research Association for Women (CRA-W) Travel Scholarship, San Francisco, CA |
| Oct 2014 | 1000$, Grace Hopper Celebration Scholarship for Grace Hopper Celebration Conference (GHC 2014), Phoenix, AZ |

## CONFERENCE ACTIVITY/ PARTICIPATION

### Conferences Organized

**Facilitator,** US Department of Education's Office of Education Technology (OET), Research on Artificial Intelligence for Education Listening sessions for National Educational Technology Plan (NETP) report.

**Organizing Team,** CIRCLS'21, Remake "Broadening" in Research on Emerging Technologies for Teaching and Learning. (Virtual Convening, 2021)

**Virtual Conference Chair,** ACM (Association of Computing Machinery) MobileCHI 2020, Expanding the horizons of mobile interactions, ACM. (Organized by University of Oldenberg, Germany)

### Papers Presented

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|---|---|
| 2021 | PhD Thesis Defense: Formative fugues: Conceptualizing data-driven formative feedback for open-ended learning environments |
| 2021 | Preliminary Defense: Formative fugues: Conceptualizing data-driven formative feedback for open-ended learning environments |
| 2020 | Formative Fugues: Helping Learners Understand Complex Systems through Causal Inference and Lag Sequential Analysis. 5th Conference on Complex Systems, Satellite Symposium on Complex Systems and Education: Research and Practice, 2020. |
| 2020 | Exploration Maps Beyond Scores, Educational Data Mining Doctoral Consortium, 2020. |
| 2020 | Exploration Support a novel support concept for open-ended learning environments, Digital Promise Global – CIRCLS team. |
| 2019 | Connect-to-Connected Worlds: Piloting a Mobile, Data-Driven Reflection Tool for an Open-Ended Simulation at a Museum. In *2019 CHI Conference on Human Factors in Computing Systems* |
| 2015 | Developing Computational Methods to Measure and Track Learners' Spatial Reasoning in an Open-Ended Simulation. *Journal of Educational Data Mining* |

## TECHNICAL SKILLS

| | |
|---|---|
| Programming Languages | C, C++, Java , Python |
| Version Software | Git (Version Software), SVN (Version Software) |
| Machine Learning / Data Mining Libraries | Scikit Learn (Sklearn Python package), R, NLP (nltk package), |

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| Causal Inference | DoWhy (Causal Inference Python package), Causal Fusion (web-based causal inference tool) |
| Visual Analytics | OpenPose, OpenCV |
| Network Analysis | NetworkX (Python SNA package), Gephi, PyVis (Network, visualization package) |
| Scripting Languages | Shell scripting, PHP |
| Front-end design | HTML, JavaScript, CSS, React |
| Visualization Libraries | D3 Library |
| Databases | Oracle, MySQL, SQL, PL/SQL, MongoDB |

## PROFESSIONAL EXPERIENCE

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|---|---|
| Feb 2015 - Aug 2016 | **Technical Consultant**<br>Perficient Inc, Chicago, IL |
| Jun 2013 - Dec 2013 | **Network Software Intern**<br>Tarana Wireless Inc., Santa Clara, CA |
| Aug 2011 - Jul 2012 | **Programmer Analyst Trainee, Banking and Finance Sector**<br>Cognizant Technology Solutions, Pune, India |

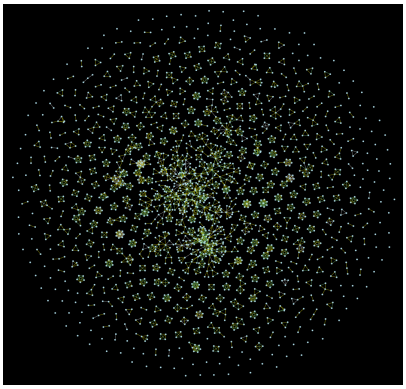
## PROJECTS

### Co-designing data advocacy toolkit with youth as design partners


Engaging youth from underserved communities with data advocacy in informal settings requires special affordances to motivate the youth to adopt the data-based tools for advocacy, post design. This includes supporting the youth in critically thinking with and about the data to craft advocacy initiatives. We position the youth as equal partners in the design process to explore the affordances that are appealing to them, using card based participatory design approach we identified disciplinary and collaborative affordances for data literacy and advocacy curriculum design. The participants identified 4 disciplinary roles (data scientist, data detective, data artist, and data journalist) and multiple tasks for each role for a data-based advocacy project.

## Mapping emerging education al technology research through funding sources

National Science Foundation research is widely known to be of world-class quality, but researchers often need resources that inform recent developments, information about experts and expertise. We use funding information of emergent educational technology research domain to map start-of-the-art progress of the scientific work with an intention of understanding the network of collaborations and scientific research of emergent educational technology. We apply natural language processing (NLP) techniques, social network analysis and data visualization to collect, map, mine the information to highlight gaps and overlaps in the research.



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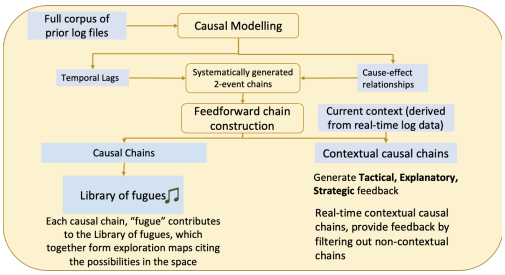
## Formative feedback for exploring Complexity in open-ended learning environments

Conceived a novel data-driven approach to extract formative feedback, called "formative fugues," suitable for guiding learners exploring complex systems concepts in open-ended learning environments. The approach learns common patterns of explorations by extracting scientifically meaningful sequences from a corpus of data of prior learners' explorations of a system. These common patterns, dubbed "fugues", can be reused, repurposed and reassembled into longer chains much like musical fugues. The computational approach leverages causal modeling followed by pattern matching to identify the formative fugues from among multiple simultaneous causal chains that occur during a given enactment. (Mallavarapu, Uzzo, & Lyons , 2021)

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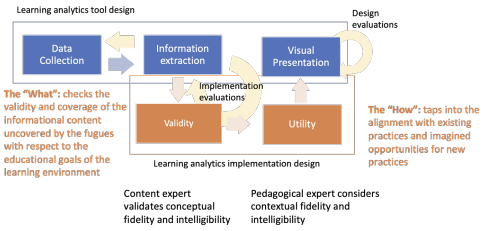
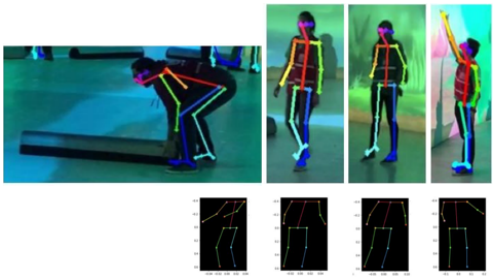
## Modified Implementation design for design of data-driven socio-technical learning and teaching tools

Designing data-driven tools for learning and teaching does not end with generating computational outputs: it is critical to attend to the ways those outputs will be integrated into human practices. The information a computational system *can* provide shapes which educational practices are possible. To attend to these intertwined dependencies, it is crucial to engage practitioners to validate the interpretability (what) and utility (how) of the outputs. This methodology applied to computationally generated formative fugues, (1) helped identify the alignment of the fugues with the educational goals of the learning environment, (2) highlighted the interpretability of the information by identifying practices afforded by fugues, and (3) suggested recommendations for delivery of the fugues. This design technique dubbed as Multistage Implementation Design (MID), is inspired from the implementation design technique by (Wise & Vytasek, 2017) used for evaluating learning technology designs.



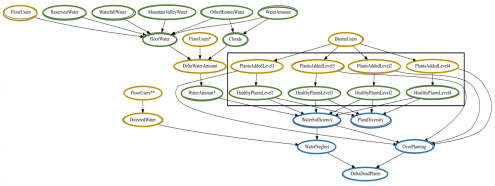
### OpenPose and Clustering to Extract Action Poses from Video Data for Studying Embodied Collaboration

Collaboration often is studied in terms of the contribution of individual actions towards the collective task. In virtual learning environments log files can capture learner actions, but in large mixed-reality and embodied learning environments, it is pragmatically difficult to log these actions. We used the automatic skeleton detection algorithm, OpenPose, on video data. The algorithm detects collaborative actions based on skeletal postures of co-located museum visitors collaborating on a problem-solving task, and automatically assigns action labels to understand their contribution to the group task.



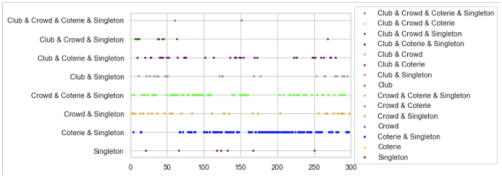
### Causal Modeling for Generating Formative Feedback

This work highlights design principles for constructing a causal graphical model of an open-ended learning environment through a case study of a museum exhibit, Connected Worlds, for generating formative feedback for explorations. The causal model learns system behavior from the causal relationships and temporal dependencies between the human and system events from prior learners' interaction data. This involved constructing outcome metrics to evaluate the state of the complex-system environment, selecting the granularity of the cause-and-effect nodes (visitor action and systemic action nodes) that constitute a complex system. The model uses causal inference to compute time lags that can accurately explain complex systems phenomena. (Mallavarapu, Lyons, Zheleva, & Uzzo, in preparation).



### Social Network Analysis for Gauging "Collaborative Temperature"

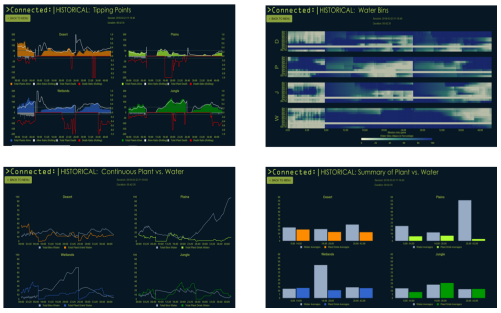
Constructed a low-cost, low-effort, ethical method to detect ephemeral social configurations in a co-located museum environment, captured through video data. For each frame a network was constructed using the principles of proxemics. Social network analysis was used to extract features of collaboration, which were then clustered using K-means algorithm to decipher social configurations. The combinations of different social configurations determines the "collaborative temperature" of visitors' interactions in the exhibit, and were used to study the impact of an educational intervention. Additionally, this passive method of studying collaboration preserves the privacy of visitors. (Mallavarapu, Lyons, & Uzzo, 2022).



### Data-Driven Dashboard Participatory Design Sessions

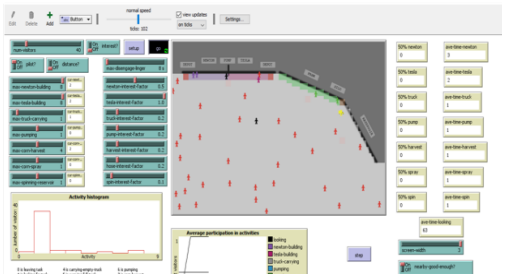
Data-driven dashboards are being integrated into various contexts as a way of informing ongoing processes, allowing a ``human-in-the-loop'' to use the dashboard to reflect on and guide activities. Embedding non-expert practitioners in the design process is critical for producing designs that they will actually use. I helped design a novel participatory methodology that helps practitioners unfamiliar with data mining to meaningfully incorporate data analytics and visualizations into their brainstorming. The study involved co-designing a data-driven dashboard for an immersive educational simulation. (Beheshti, Lyons, Mallavarapu, Wallingford, Thompson, & Uzzo, 2020).

### Connect-to-Connected Worlds, a Data-Driven Dashboard



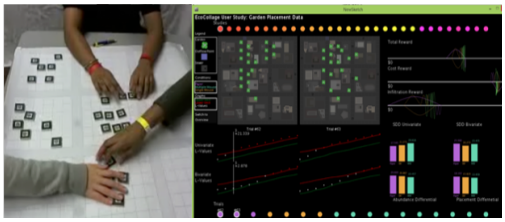
Created web-based tablet support for facilitators, researchers and visitors to the New York Hall of Science's Connected Worlds immersive simulation exhibit. This involved creating architecture to scrape live data from the exhibit while it is in use, deliver it to a database, and visualize the results in an on-demand fashion on tablets carried within the exhibit. These live, dynamic data visualizations can help visitors understand how their manipulations affect the simulated ecosystem's sustainability (Mallavarapu, Lyons, Uzzo, Thompson, Levy-Cohen, & Slattery, 2019).

### Modeling Connected Worlds to Promote Collective Usability



Created a data-driven model of how museum visitors moved around within and made use of a pilot version of the Connected Worlds exhibit. Used a complex system simulation tool (NetLogo) to model the layout and movement of visitors and the space, as informed by real-world measurements of visitor movements and engagement. Ran dozens of different permutations to understand which changes to the exhibit design could improve the collective usability of Connected Worlds. (Lyons & Mallavarapu, 2020)

### EcoCollage

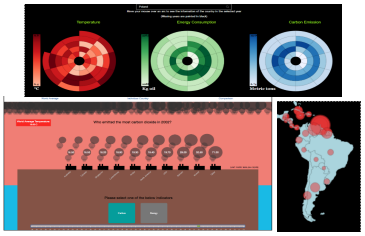


Designed metrics to evaluate and track the learners' spatial reasoning skills when using an Urban Planning simulation. Used spatial metrics like Ripley's K and diversity metrics to derive a measure for spatial reasoning and applied regression to characterize the different spatial arrangements as good or bad strategies relative to simulation outcomes. The results were used to examine if the user interface design affected the way in which learners approached exploring the problem space: did they use different spatial strategies, or discover them more quickly or more slowly, when using different user interfaces? (Mallavarapu, Lyons, Slattery, Shelley, Minor, & Zellner, 2015)

**Empirical Analysis of Data-Driven Formative Feedback**


To understand the empirical effect of data-driven reflective formative feedback on visitors' collective actions in an open-ended simulation exhibit, we used visitors' interaction data to provide reflection opportunities to the visitors. We used case-study approach, with two visitor groups, one group reflected with the data-driven tool and other only verbally reflected their experiences. The group who reflected using the data-based feedback were able to more playfully and consciously modify their strategies to engage with the exhibit. (Mallavarapu, Lyons, Uzzo, Thompson, Levy-Cohen, & Slattery, 2019)

**World Climate Change Dashboard**



The past few decades have seen adverse climate changes because of carbon dioxide being generated by humans around the globe. Knowing how to set policies can be difficult without knowing how carbon generation is distributed across human activities, and across geographic locations. We have created a dashboard that allows juxtaposing, comparing, and understanding the progression of climate change due to carbon footprints around the world.

## STUDENTS SUPERVISED

| | |
|---|---|
| Zak Risha | University of Pittsburgh, PhD Information Science,<br>Expected Graduation Fall 2025 |
| Lydia Tse | University of Illinois at Chicago, MS Computer Science, Graduated Spring 2020<br>Visualization Engineer, NIKE |
| Noah Phillips | University of Pittsburgh, BS Computer Science,<br>Expected Graduation Spring 2022 |
| Benjamin Truckenbrod | University of Pittsburgh, BS Computer Science,<br>Expected Graduation Spring 2022 |
| Lydia Tse | University of Illinois at Chicago, BS Computer Science,<br>Graduated Spring 2018<br>Visualization Engineer, NIKE |
| Eric Leon | University of Illinois at Chicago, BS Computer Science,<br>Graduated Spring 2017<br>Software Engineer, PayPal |

## SERVICE & VOLUNTEER EXPERIENCE

**Professional Societies**

Educational Data Mining (EDM)
Society for Learning Analytics Research (SOLAR)
International Society for Artificial Intelligence for Education (AIED)
Association for Computing Machinery (ACM)
Association for Computing Machinery – Special Interest Group for Computer and Human Interaction (ACM-SIGCHI)
International conference for Computer Supported Collaborative Learning (ICLS)
Computer Supported Collaborative Work (CSCW)
Computing Research Association-Widening Participation (CRA-WP)

**Program Committee**

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|---|---|
| 2022 | International Conference of Artificial Intelligence in Education (AIED), 2022. |
| 2022 | International Conference for Educational Data Mining (EDM), 2022. |

**Reviewer**

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|---|---|
| 2022 | International Journal of Computer Supported Collaborative Work, (ijCSCW) |
| 2021 | International Conference of Computer Supported Collaborative Learning (CSCL), 2022. |
| 2021 | International Journal for Artificial Intelligence in Education (AIED). |
| 2020 | International Conference on Human Factors in Computing Systems (ACM-CHI), 2020. |

**Invited Talks**

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| Nov 2021 | **Invited Speaker,** *Using Data Mining and Learning Analytics to improve learning and teaching in social settings.* Instructional Technology and Learning Sciences Department, Utah State University. |
| Sep 2021 | **Invited Speaker,** *Using Learning Sciences and Computational Approaches to develop Assessments and Intelligent Tutoring Systems***.** Expertise Exchange series, 2021 CIRCLS Convening. |
| Mar 2021 | **Invited Speaker,** *Using Artificial Intelligence at Museums for Engaging Visitors and Uncovering Learning.* Florida Museum of Natural History, University of Florida. |

**Community Service**

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|---|---|
| Sep 2021 | **Facilitator,** Strategy Session on Learning Analytics Research Methods, 2021 CIRCLS Convening |
| Sep 2021 | **Blogger,** Society for Learning Analytics Research Nexus |
| Mar 2018 | **Judge**, 2018 CPS Exhibition of Student STEM Research |
| Jan 2017 – Dec 2017 | **Volunteer Mentor** for the Girls Who Code UIC division. |
| Dec 2016 | **Volunteer** for Hour of Code at the Skinner North Elementary School, IL |
| Aug 2015 | **Volunteer**, Millet Project at University of California Berkeley, CA for Plant and Microbiology Department. |
| Aug 2012 – Dec 2021 | **Member**, Women in Computer Science at UIC. |