
Generative AI for Education (GAIED): Advances, Opportunities, and Challenges

Abstract

GAIED (pronounced “guide”) aims to bring together researchers, educators, and practitioners to explore the potential of generative AI for enhancing education.

Main Proposal

<https://gaied.org/neurips2023>

Workshop Topic and Content

Introduction. This workshop, GAIED (pronounced “guide”), aims to bring together researchers, educators, and practitioners to explore the potential of generative AI for enhancing education. Such an exploration, jointly as a community, is time critical: Recent advances in generative AI, in particular deep generative and large language models like ChatGPT, are bringing in transformational effects on the educational landscape. On the one hand, these advances provide unprecedented opportunities to enhance education by creating unique human-machine collaborative systems, e.g., these models could act as personalized digital tutors for students, as digital assistants for educators, and as digital peers to enable new collaborative learning scenarios. On the other hand, the advanced capabilities of these generative AI models have brought unexpected challenges for educators and policymakers worldwide, causing a chaotic disruption in universities and schools to design regulatory policies about the usage of these models. The workshop will investigate these opportunities and challenges in education by focusing the discussions along two thrusts:

- I. **GAI→ED:** Exploring how recent advances in generative AI provide new opportunities to drastically improve state-of-the-art educational technology.
- II. **ED→GAI:** Identifying unique challenges in education caused by these recent advances and how to tackle them by bringing in desired safeguards along with technical innovations in generative AI.

For us to fully realize these opportunities and tackle these challenges, it is crucial to build a community of researchers, educators, and practitioners that are “multilingual” with (a) technical expertise in the cutting-edge advances in generative AI, (b) first-hand experience of working with students in classrooms, and (c) know-how of building/deploying educational technology at scale. The goal of GAIED is to foster such a multilingual community. The workshop will bring together speakers and participants with diverse backgrounds ranging from researchers in human-computer interaction, learning sciences, natural language processing, and program synthesis to industry practitioners and educators directly involved in educational activities. Moreover, the workshop program, including two panels and breakout group discussions, is designed to facilitate new connections, inspire novel ideas, and create fruitful partnerships.

Topics of Interest. We will investigate the above-mentioned thrusts on GAI→ED and ED→GAI along several topics related, but not limited, to:

- (GAI→ED) Sharing viewpoints, novel ideas, or field experiences about using generative AI in real-world educational settings.
- (GAI→ED) Exploring the capabilities of generative AI and large-language models in novel educational scenarios, e.g., personalized content generation and grading.
- (GAI→ED) Exploring novel human-machine collaborative systems where generative models play different roles, e.g., as digital tutors, assistants, or peers.

- (ED→GAI) Sharing viewpoints, unique challenges, or field experiences about concerns among educators and policymakers in using generative AI.
- (ED→GAI) Developing novel prompting and fine-tuning techniques to safeguard the outputs of generative AI and large-language models against biases and incorrect information.
- (ED→GAI) Developing novel safeguarding techniques to validate the authenticity of content, e.g., to determine whether an assignment was written by students or generated by models.

Call for Papers and Participation (CFP). Below, we share a few points related to the CFP:

- We will solicit two types of submissions: (1) research papers reporting results of ongoing or new research; (2) position papers reporting new viewpoints or field experiences.
- We will use the OpenReview portal. Submissions will be limited up to 6 pages of content with unlimited additional pages for references or appendices. The reviewing process will be double-blind. Submissions deadline date will be Sep 25, 2023 AOE; notifications date will be Oct 20, 2023 AOE.
- Accepted papers will be presented as posters. We will accept up to 25 papers and expect to receive about 50 submissions. Accepted papers will be considered non-archival, though we will make them available on the workshop webpage.
- Based on our previous experience, we will make the CFP more welcoming by highlighting that the workshop welcomes attendance from individuals who do not have something they'd like to submit but are still interested in the workshop topics.

Attendance. Based on our past experience in organizing similar workshops, we estimate over 120 in-person attendees. In addition, we estimate over 50 online attendees. The workshop will bridge ideas between generative AI (one of the central topics in AI) and education (one of the key domains for societal impact). Given that both these topics are very timely and of huge significance to the NeurIPS community, we expect the workshop will attract considerable interest and engagement.

Earlier Versions. This is the first workshop event for GAIED. Nevertheless, there have been several workshops organized on the topic of AI for education. In fact, we (the organization team for GAIED) have been extensively involved in co-organizing related workshops at top-tier conferences: workshop “Empowering Education with LLMs – The Next-Gen Interface and Content Generation” at AIED’23; workshop “Automatically Generating CS Learning Materials with Large Language Models” at SIGCSE’23; workshop “Reinforcement Learning for Education” at AAI’22, EDM’21; workshop “Machine Learning for Education” at NeurIPS’20. We have included these details in the next section when discussing the relevant experiences of the organization team.

Tentative List of Invited Speakers and Schedule

Tentative List of Invited Speakers. Below we provide a list of invited speakers; these speakers will also serve as panelists. Speakers who have already agreed are marked by *Name. For the remaining (1/8), we have sent an invitation and will seek confirmation before publicly announcing the list.

- *Ibrahim Albluwi (Princess Sumaya University for Technology, Jordan).
<https://ialbluwi.github.io/>.
- *Cynthia Breazeal (Massachusetts Institute of Technology, USA).
<https://www.media.mit.edu/people/cynthiab/overview/>.
- *Elena Glassman (Harvard University, USA).
<https://glassmanlab.seas.harvard.edu/>.
- *Hieke Keuning (Utrecht University, Netherlands).
<http://www.hkeuning.nl/>.
- *Tobias Kohn (TU Wien, Austria).
<https://tobiaskohn.ch/>.
- Percy Liang (Stanford University, USA).
<https://cs.stanford.edu/pliang/>.
- *Lu Wang (University of Michigan, USA).
<https://web.eecs.umich.edu/wangluxy/>.
- *Simon Woodhead (Eedi, UK).
<https://www.linkedin.com/in/simon-woodhead/>.

Tentative Schedule. We plan to have a 7-hour-long workshop program along with a 1-hour lunch break and a short coffee break. At a high level, the program will consist of two sessions: (Session I) the morning session will focus on the thrust GAI→ED topics mentioned above; (Session II) the afternoon session will focus on the thrust ED→GAI topics. Each session will comprise invited talks, poster presentations from accepted papers, a panel, and breakout group discussions; these breakout groups will be an organized community-building activity where attendees will discuss specific topics as a precursor to panel discussions. Below we provide a tentative schedule for the workshop; times are listed in US Central Time, i.e., local time at the conference location.

08:55 – 09:00	Introduction and opening remarks
SESSION I. GAI→ED: Advances in GAI and New Opportunities for ED	
09:00 – 09:20	Invited Talk: 15 mins presentation + 5 mins discussion
09:20 – 09:40	Invited Talk: 15 mins presentation + 5 mins discussion
09:40 – 10:00	Invited Talk: 15 mins presentation + 5 mins discussion
10:00 – 10:45	Posters: Accepted papers on GAI→ED topics
10:45 – 11:30	Breakout Groups: Organized discussions among attendees on GAI→ED topics
11:30 – 12:15	Panel: Discussion on GAI→ED topics
12:15 – 13:15	Lunch Break
SESSION II. ED→GAI: Challenges in ED and Required Innovations for GAI	
13:15 – 13:35	Invited Talk: 15 mins presentation + 5 mins discussion
13:35 – 13:55	Invited Talk: 15 mins presentation + 5 mins discussion
13:55 – 14:15	Invited Talk: 15 mins presentation + 5 mins discussion
14:15 – 15:00	Posters: Accepted papers on ED→GAI topics
15:00 – 15:15	Coffee Break
15:15 – 15:30	Invited Talk: 10 mins presentation + 5 mins discussion
15:30 – 15:45	Invited Talk: 10 mins presentation + 5 mins discussion
15:45 – 16:30	Breakout Groups: Organized discussions among attendees on ED→GAI topics
16:30 – 17:15	Panel: Discussion on ED→GAI topics
17:15 – 17:30	Community discussion about next steps and closing remarks

Diversity Statement

We have made a substantial effort to ensure diversity in the list of speakers and the organization team. Next, we highlight how we addressed diversity among speakers and organizers in different aspects:

- **Diversity in viewpoints, thinking, and expertise.** The list of speakers and organization team includes people with diverse backgrounds and expertise who will bring various viewpoints and thinking from varying experiences with generative AI for education. On the one hand, this includes researchers in didactics, human-computer interaction, learning sciences, natural language processing, program synthesis, and social robotics. On the other hand, this includes industry practitioners and educators directly involved in educational activities.
- **Diversity in gender.** The list of speakers includes 4 out of 8 speakers as women. The organization team includes 2 out of 7 members as women.
- **Diversity in demographics.** The list of speakers spans 8 institutes across 5 countries and over 5 nationalities. The organization team spans 7 institutes across 4 countries and 4 nationalities.
- **Diversity in seniority.** The list of speakers includes 4 early career researchers from academia, 3 senior researchers from academia, and 1 senior member from industry. The organization team includes 1 Ph.D. student, 2 early career researchers from academia, 3 senior researchers from academia, and 1 senior member from industry.

Throughout the workshop organization, we will continue to spend substantial outreach efforts to encourage diverse participants to contribute and attend the workshop. In addition, the diversity of the team with extensive organizational experience will further help reach out to diverse participants.

Organizers

As organizers, we bring in the necessary expertise on topics relevant to this workshop and diverse viewpoints stemming from our different backgrounds. Furthermore, we have extensive experience organizing related workshops and other academic events (including physical, hybrid, and virtual events). Our expertise, experience, and passion for topics related to generative AI for education would ensure that the proposed workshop is successful. This section provides details about the organization team and program committee. In the next section, we provide a selected list of past academic events organized by the team and selected publications of the team.

Organization Team

Paul Denny is an Associate Professor in the School of Computer Science at the University of Auckland in Auckland, New Zealand. His research interests include developing and evaluating tools for supporting collaborative learning, improving outcomes for novice programmers, and exploring the ways that students engage with online learning environments. He has received numerous awards for his research, including 11 best paper awards at flagship computing education and human-computer interaction venues. His PeerWise project, a pioneering learnersourcing platform, won the 2018 QS Reimagine Education Overall Award placing first out of 1200 entries. He is currently co-leading an ITiCSE working group which includes 16 academics worldwide who are interested in the impact of generative AI, specifically on computing education. He has also been involved in co-organizing a number of academic events, including the workshop “Empowering Education with LLMs – The Next-Gen Interface and Content Generation” at AIED’23 and “Automatically Generating CS Learning Materials with Large Language Models” at SIGCSE’23. He is currently serving as a Program Co-Chair for ICER’23. Email: <p.denny@auckland.ac.nz>; Web: <https://profiles.auckland.ac.nz/p-denny>.

Sumit Gulwani is a Partner Research Manager at Microsoft in Redmond, WA, USA. He leads the PROSE research and engineering team at Microsoft that develops APIs for program synthesis and has incorporated them into various Microsoft products. He invented the popular Flash Fill feature in Excel, which has now also found its place in middle-school computing textbooks. He has started a novel research fellowship program in India, a remote apprenticeship model to scale up impact while nurturing globally diverse talent and growing research leaders. He has co-authored 10+ award-winning papers (including 3 test-of-time awards from ICSE and POPL) amongst 140+ research publications across multiple computer science areas and delivered 60+ keynotes/invited talks. He was awarded the Max Planck-Humboldt medal in 2021 and the ACM SIGPLAN Robin Milner Young Researcher Award in 2014 for his pioneering contributions to program synthesis and intelligent tutoring systems. Email: <sumitg@microsoft.com>; Web: <https://www.microsoft.com/en-us/research/people/sumitg/>.

Neil T. Heffernan is a Full Professor of Computer Science and the Director of the Learning Sciences and Technologies program at Worcester Polytechnic Institute in Worcester, MA, USA. He is passionate about educational data mining and randomized controlled experimentation. He developed ASSISTments to help teachers be more effective in the classroom and to conduct research to improve the quality of education. He created the E-TRIALS Testbed, a tool that allows ASSISTments to be used as a platform to do science. He has written 60+ papers on learning analytics, 20+ papers on the results of randomized controlled trials, and has also been hosting educational data mining competitions. His work has received national press from U.S. News, Scientific American, The New York Times, The Boston Globe, and NPR. He has been involved in co-organizing a number of related workshops, including the workshop “Machine Learning for Education” at NeurIPS’20. Email: <nth@wpi.edu>; Web: <https://www.neilheffernan.net/>.

Tanja Käser is an Assistant Professor at the School of Computer and Communication Sciences at EPFL in Lausanne, Switzerland, where she leads the Machine Learning for Education lab (ML4ED). Her research lies at the intersection of machine learning, data mining, and education. She is particularly interested in creating accurate models of human behavior and learning. She has received several awards for her work, including 4 best paper awards at top-tier conferences in the area of educational data mining and intelligent tutoring systems. She received her Ph.D. degree from the Computer Science Department of ETH Zurich, and her thesis was distinguished with the Fritz Kutter Award for the best Computer Science thesis at a Swiss university. She is currently serving as a Program Co-Chair for EDM’23. Email: <tanja.kaeser@epfl.ch>; Web: <https://people.epfl.ch/tanja.kaeser/>.

Steven Moore is a Ph.D. student at the Human-Computer Interaction Institute, Carnegie Mellon University in Pittsburgh, PA, USA. His research interests include educational data mining and computer science education. His ultimate goal is to improve the education of introductory programming to non-majors via adaptive and interactive activities. His recent research has explored the role of large-language models in assessing the quality of student-generated short-answer questions. He has also been involved in co-organizing a number of closely related workshops, including the workshop “Empowering Education with LLMs – The Next-Gen Interface and Content Generation” at AIED’23 and “Learnersourcing: Student-generated Content @ Scale” at Learning@Scale’22. Email: <stevenmo@andrew.cmu.edu>; Web: <https://stevenjamesmoore.com/>.

Anna N. Rafferty is an Associate Professor of Computer Science at Carleton College in Northfield, MN, USA. Her recent work has been concerned with how to apply machine learning and artificial intelligence techniques to improve education. She has been developing algorithms to automatically diagnose students’ understanding from their actions and to determine policies for problem selection and personalizing feedback in interactive tutoring systems. She is a co-developer of *Emmy’s Workshop*, a website to help people practice their algebra skills. She has been involved in co-organizing a number of workshops at top-tier conferences: workshop “Reinforcement Learning for Education” at AAI’22, EDM’21; workshop “Reinforcement Learning for Educational Data Mining” at EDM’19; workshop “Teaching Machines, Robots, and Humans” at NeurIPS’17. She served as a Program Co-Chair for EDM’20. Email: <arafferty@carleton.edu>; Web: <https://sites.google.com/site/annanrafferty/>.

Adish Singla is a tenure-track faculty member at the Max Planck Institute for Software Systems (MPI-SWS) in Saarbrücken, Germany, where he has been leading the Machine Teaching Group since 2017. He conducts research in the area of machine teaching, with a particular focus on open-ended learning and problem-solving domains. In recent years, his research has centered around developing AI-driven educational technology for introductory programming environments. He has received several awards for his research, including an AAI’22 Outstanding Paper Honorable Mention Award, IJCAI’22 Early Career Spotlight, and an ERC Starting Grant 2021. He has been involved in co-organizing a number of workshops at top-tier conferences: workshop “Reinforcement Learning for Education” at AAI’22, EDM’21; workshop “Human-AI Collaboration in Sequential Decision-Making” at ICML’21; workshop “Teaching Machines, Robots, and Humans” at NeurIPS’17; workshop “Crowdsourcing and Machine Learning” at NeurIPS’16, ICML’15, NeurIPS’14, ICML’14. Email: <adishs@mpi-sws.org>; Web: <https://machineteaching.mpi-sws.org/adishsingla.html>.

Program Committee

Below we provide a tentative list of Program Committee members. The members who have already agreed are marked by *Name. We will seek confirmation from the remaining members before publicly announcing the CFP. We will request additional members if need be.

- *David Ifeoluwa Adelani (UCL, UK)
- Ibrahim Alblawi (PSUT, Jordan)
- *Sami Baral (Worcester Polytechnic Ins., USA)
- *José Cambrero (Microsoft, USA)
- Michael Caspersen (Aarhus University, Denmark)
- *Yuxin Chen (University of Chicago, USA)
- *Paul Denny (University of Auckland, NZ)
- Shayan Doroudi (UC Irvine, USA)
- *Ahana Ghosh (MPI-SWS, Germany)
- Elena Glassman (Harvard University, USA)
- *Alkis Gotovos (MPI-SWS, Germany)
- *Sumit Gulwani (Microsoft, USA)
- *Neil T. Heffernan (Worcester Polytechnic Ins., USA)
- *Parameswaran Kamalaruban (Alan Turing Ins., UK)
- *Tanja Käser (EPFL, Switzerland)
- Hieke Keuning (Utrecht University, Netherlands)
- Natalie Kiesler (Leibniz Ins. in Education, Germany)
- *Tobias Kohn (TU Wien, Austria)
- Viraj Kumar (IISc, India)
- Juho Leinonen (University of Auckland, NZ)
- *Liina Malva (Tallinn University, Estonia)
- *Farnam Mansouri (University of Waterloo, Canada)
- *Vukosi Marivate (University of Pretoria, South Africa)
- *Shubham Mittal (University of Wisconsin, USA)
- *Steven Moore (Carnegie Mellon University, USA)
- *Tanya Nazaretsky (EPFL, Switzerland)
- *Huy A. Nguyen (Carnegie Mellon University, USA)
- *Victor-Alexandru Pădurean (MPI-INF, Germany)
- Chris Piech (Stanford University, USA)
- *Ethan Prihar (Worcester Polytechnic Ins., USA)
- *Anna N. Rafferty (Carleton College, USA)
- *Amin Raksha (University of Toronto, Canada)
- Ute Schmid (University of Bamberg, Germany)
- Anjali Singh (University of Michigan, USA)
- *Adish Singla (MPI-SWS, Germany)
- *John Stamper (Carnegie Mellon University, USA)
- Lu Wang (University of Michigan, USA)
- *Daniel Weitekamp (Carnegie Mellon University, USA)

References

Selected Academic Events by Organization Team

- [1] **S. Moore**, R. Tong, Z. Liu, X. Hu, Y. Lu, J. Liang, H. Khosravi, **P. Denny**, A. Singh, C. Brooks, J. Stamper, C. Chao. Empowering Education with LLMs – The Next-Gen Interface and Content Generation. *Organized Workshop at AIED 2023 (scheduled in July)*.
- [2] S. MacNeil, A. Tran, J. Leinonen, **P. Denny**, J. Kim, A. Hellas, S. Bernstein, S. Sarsa. Automatically Generating CS Learning Materials with Large Language Models. *Organized Workshop at SIGCSE 2023*.
- [3] **S. Gulwani**. AI-Assisted Programming: Applications, User Experiences, and Neuro-Symbolic Perspectives. *Keynote at ESEC/FSE 2022*.
- [4] **S. Gulwani**. AI-Assisted Programming. *Keynote at IJCAI 2022*.
- [5] **N. T. Heffernan**, A. S. Lan, **A. N. Rafferty**, **A. Singla**. Reinforcement Learning for Education. *Organized Workshop at AAAI 2022*.
- [6] **S. Moore**, **P. Denny**, H. Khosravi, C. Brooks, J. Stamper. Learnersourcing: Student-Generated Content @ Scale. *Organized Workshop at Learning@Scale 2022*.
- [7] B. Nushi, **A. Singla**, S. Tschitschek. Human-AI Collaboration in Sequential Decision-Making. *Organized Workshop at ICML 2021*.
- [8] **N. T. Heffernan**, G. Radanovic, **A. N. Rafferty**, **A. Singla**. Reinforcement Learning for Education. *Organized Workshop at EDM 2021*.
- [9] K. Garg, **N. T. Heffernan**, K. Meyers. Machine Learning for Education. *Organized Workshop at NeurIPS 2020*.
- [10] M. Cakmak, **A. N. Rafferty**, **A. Singla**, J. Zhu, S. Zilles. Teaching Machines, Robots, and Humans. *Organized Workshop at NeurIPS 2017*.

Selected Publications of Organization Team

- [1] T. Phung, J. Cambronero, **S. Gulwani**, T. Kohn, R. Majumdar, **A. Singla**, G. Soares. Generating High-Precision Feedback for Programming Syntax Errors using Large Language Models. *EDM 2023*.
- [2] H. Joshi, J. Cambronero, **S. Gulwani**, V. Le, I. Radicek, G. Verbruggen. Repair Is Nearly Generation: Multilingual Program Repair with LLMs. *AAAI 2023*.
- [3] **P. Denny**, V. Kumar, N. Giacaman. Conversing with Copilot: Exploring Prompt Engineering for Solving CS1 Problems Using Natural Language. *SIGCSE 2023*.
- [4] S. MacNeil, A. Tran, A. Hellas, J. Kim, S. Sarsa, **P. Denny**, S. Bernstein, J. Leinonen. Experiences from Using Code Explanations Generated by Large Language Models in a Web Software Development E-Book. *SIGCSE 2023*.
- [5] R. L. Davis, T. Wambsganss, W. Jiang, K. G. Kim, **T. Käser**, P. Dillenbourg. Fashioning the Future: Unlocking the Creative Potential of Deep Generative Models for Design Space Exploration. *CHI 2023*.
- [6] S. T. Christie, H. Johnson, C. Cook, G. Gianopoulos, **A. N. Rafferty**. LENS: Predictive Diagnostics for Flexible and Efficient Assessments. *Learning@Scale 2023*.
- [7] J. M. Cock, M. Bilal, R. Davis, M. Marras, **T. Käser**. Protected Attributes Tell Us Who, Behavior Tells Us How: A Comparison of Demographic and Behavioral Oversampling for Fair Student Success Modeling. *LAK 2023*.
- [8] J. Gan, R. Majumdar, G. Radanovic, **A. Singla**. Envy-Free Policy Teaching to Multiple Agents. *NeurIPS 2022*.
- [9] G. Poesia, A. Polozov, V. Le, A. Tiwari, G. Soares, C. Meek, **S. Gulwani**. Synchromesh: Reliable Code Generation from Pre-Trained Language Models. *ICLR 2022*.
- [10] S. Sarsa, **P. Denny**, A. Hellas, J. Leinonen. Automatic Generation of Programming Exercises and Code Explanations Using Large Language Models. *ICER 2022*.
- [11] J. Finnie-Ansley, **P. Denny**, B. A. Becker, A. Luxton-Reilly, J. Prather. The Robots Are Coming: Exploring the Implications of OpenAI Codex on Introductory Programming. *ACE 2022*.
- [12] A. F. Botelho, E. Prihar, **N. T. Heffernan**. Deep Learning or Deep Ignorance? Comparing Untrained Recurrent Models in Educational Contexts. *AIED 2022*.
- [13] A. Ghosh, S. Tschitschek, S. Devlin, **A. Singla**. Adaptive Scaffolding in Block-based Programming via Synthesizing New Tasks as Pop Quizzes. *AIED 2022*.

- [14] S. Bhat, H. A. Nguyen, **S. Moore**, J. Stamper, M. Sakr, E. Nyberg. Towards Automated Generation and Evaluation of Questions in Educational Domains. *EDM 2022*.
- [15] J. M. Cock, M. Marras, C. Giang, **T. Käser**. Generalisable Methods for Early Prediction in Interactive Simulations for Education. *EDM 2022*.
- [16] T. Wambsganss, V. Swamy, R. Rietsche, **T. Käser**. Bias at a Second Glance: A Deep Dive into Bias for German Educational Peer-Review Data Modeling. *COLING 2022*.
- [17] G. Yengera, R. Devidze, P. Kamalaruban, **A. Singla**. Curriculum Design for Teaching via Demonstrations: Theory and Applications. *NeurIPS 2021*.
- [18] R. Devidze, G. Radanovic, P. Kamalaruban, **A. Singla**. Explicable Reward Design for Reinforcement Learning Agents. *NeurIPS 2021*.
- [19] R. A. Jansen, **A. N. Rafferty**, T. L. Griffiths. A Rational Model of the Dunning–Kruger Effect Supports Insensitivity to Evidence in Low Performers. *Nature Human Behavior 2021*.
- [20] S. Baral, A. Botelho, J. Erickson, P. Benachamardi, **N. T. Heffernan**. Improving Automated Scoring of Student Open Responses in Mathematics. *EDM 2021*.
- [21] **A. Singla**, **A. N. Rafferty**, G. Radanovic, **N. T. Heffernan**. Reinforcement Learning for Education: Opportunities and Challenges. *arXiv 2107.08828 2021*.
- [22] U. Ahmed, M. Christakis, A. Efremov, N. Fernandez, A. Ghosh, A. Roychoudhury, **A. Singla**. Synthesizing Tasks for Block-based Programming. *NeurIPS 2020*.
- [23] N. Natarajan, D. Simmons, N. Datha, P. Jain, **S. Gulwani**. Learning Natural Programs from a Few Examples in Real-Time. *AISTATS 2019*.
- [24] X. Zhu, **A. Singla**, S. Zilles, **A. N. Rafferty**. An Overview of Machine Teaching. *arXiv 1801.05927 2018*.
- [25] **S. Gulwani**, I. Radicek, F. Zuleger. Automated Clustering and Program Repair for Introductory Programming Assignments. *PLDI 2018*.