iSAT Snapshot

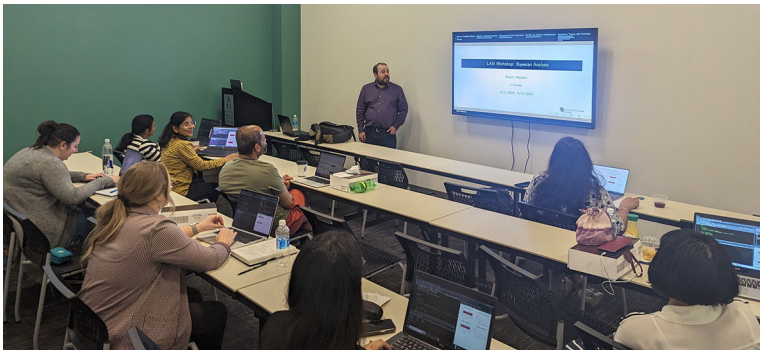
NSF AI INSTITUTE FOR STUDENT-AI TEAMING

Summer 2024

In Brief . . .

A quick look at our activities this quarter!

1. iSAT strand lead Tamara Sumner discussed how iSAT is designing AI partners to help transform schools in an article for The Economist. She was also an AI Steering Committee Member for the Colorado Roadmap for AI in K-12 education.
2. iSAT PI Sidney D'Mello discussed new approaches for AI to support learning in the "The District Leader's Guide to AI: Navigating AI Adoption in Education" created by Saga Education.
3. The iSAT High School Internship Program increased its cohort this year from four to seven interns from two local school districts who presented their internship research projects to iSAT team members. During four, 10–15-minute presentations, the interns covered projects from each of our research strands.
4. iSAT interns helped lead a week-long STEM camp held in conjunction with a partner school district. Over 40 students attended and learned about iSAT's curriculum such as the Self-Driving Cars unit as well as AI, cybersecurity, robotics and more!
5. iSAT-affiliated Research Scientist, Robert Moulder, led a two day workshop on Bayesian Analysis at the Learning Analytics Summer Institute (LASI). The conference was hosted by The Society for Learning Analytics Research (SoLAR), which is an interdisciplinary network of leading international researchers who are exploring the role and impact of analytics on teaching.
6. iSAT PI Sidney D'Mello joined the NSF's Education Directorates EDU Advisory Committee (AC). He participated in the AC's Spring 2024 meeting focused on Rural STEM education in DC.



iSAT-affiliated Research Scientist, Robert Moulder, leads a workshop at the Learning Analytics Summer Institute

iSAT Recent Awards:

iSAT Strand 1 team members received two best paper awards!

PhD student Jiani Wang, with co-authors Shiran Dudy (formerly of iSAT), Xinlu He, Zhiyong Wang (formerly of iSAT), Rosy Southwell, and Jacob Whitehill received the Best Student Short Paper award for their paper "Speaker Diarization in the Classroom: How Much Does Each Student Speak in Group Discussions?" at the 17th International Conference on Educational Data Mining (EDM2024).

The paper "Propositional Extraction from Natural Speech in Small Group Collaborative Tasks," authored by Videep Venkatesha, Avyakta Chelle, James Pustejovsky, Abhijnan Nath, Mariah Bradford, Nathaniel Blanchard, Ibrahim Khebour, Jingxuan Tu, and Nikhil Krishnaswamy, won Best Student Long Paper.

From the PI

We completed our Year 4 site visit where we welcomed program officers from the National Science Foundation and an External Site Visit Team. It was a hectic but memorable day and a half of presentations and discussions that showcased, among many of our advancements, the Institute's strong commitment to research convergence and cross-strand integration. The evaluators were very pleased with our progress, commenting that "the synergy across the iSAT team is exciting to see and is strongly connected to the convergent science that iSAT is advancing" and that "iSAT is serving as an excellent example of an effective AI Institute." They also concluded that our management structures were "mature and impactful," which was particularly pleasing given that we created this organization from the ground up in the midst of the pandemic less than four years ago. I want to give a huge thank you to our team for the amazing ideas, enthusiasm, and dedication that they bring to the Institute!

Looking towards Y5, in addition to advancing our outstanding research program, it is critical that iSAT focuses its strategic impacts outwards - by impacting more students, educators, researchers, community members, and other stakeholder to envision, co-create, critique, and apply student-AI teaming technologies in their schools and communities. We are planning a number of initiatives to meet this goal. These include expanding our partnerships with school districts to expand the impacts of our AI-enabled curriculum on more diverse students, exploring strategic collaborations with industry affiliates to increase the reach of iSAT technologies by embedding them into their products, and building community and capacity through workshops and trainings to socialize the science of student-AI teaming towards the broader research community. I'm excited to welcome our new and future collaborators and partners on these and other exciting initiatives that lie ahead.

Feature: New Demos at the Year 4 Site Visit

Jigsaw Interactive Agent (JIA) and Multimodal Analytics

One of the exciting agenda items of convergence in action this year were our expanded range of technology demos showcased at the NSF site visit. We demoed the latest versions of our Community Builder (CoBi) AI Partner and the Speech Processing Pipeline, which included several new components including our 'influence measure' and abstract meaning reasoning parsing. Here, we highlight the Jigsaw Interactive Agent (JIA) and our advances in the Multimodal Analysis of Social Dynamics—*our new kids on the block*, so to speak.

JIA Demo Presentation

Jigsaw activities are a type of collaboration where students first develop initial expertise and then come together to pool their knowledge in an effort to solve more complex problems. The intent is for JIA to boost more effective knowledge sharing that can scaffold engagement and lead to increased social cohesion.

The demo featured a team of three iSAT researchers playing the roles of a student group completing the jigsaw collaborative activity with hardware sensors—the same hardware that students use in our Sensor Immersion (SI) curriculum unit. JIA detects the group state in real time and offers a suggested response. A bit off to the side was an expert who observed the team working together and would select one of JIA's recommendation to pass on to the student via their own user interface.

For this demo we presented two likely common scenarios. For scenario 1, we imagined that JIA detects that students are somewhat quiet; in this situation, JIA will generate the prompt "Who would like to share their idea?" to encourage students to start sharing ideas. For scenario 2, the focus shifted to JIA detecting confusion in the group. JIA then provides guidance on further discussion by generating different prompts. For example, JIA prompted team members to share with each other what their individual sensors might have in common. JIA then guided the group to discuss how their sensors can be used together.

The group's verbal interactions are analyzed in real time using GPU-enabled laptops and iSAT's customized automated speech processing pipeline which includes speech recognition, speaker diarization, and analysis of collaborative discourse.

Multimodal Analytics Demo

Collaborative Learning Environments encourage the construction of knowledge in a group, a process which is correlated, not only with verbal interactions, but importantly, with nonverbal behaviors. A transcript of student talk by itself can hide important information about the collaboration. Multimodal analytics helps identify how students interact nonverbally in conjunction with their verbal participation, providing a more expansive understanding of a student learner's overall participation in a group setting and, hence, their collaboration and engagement.

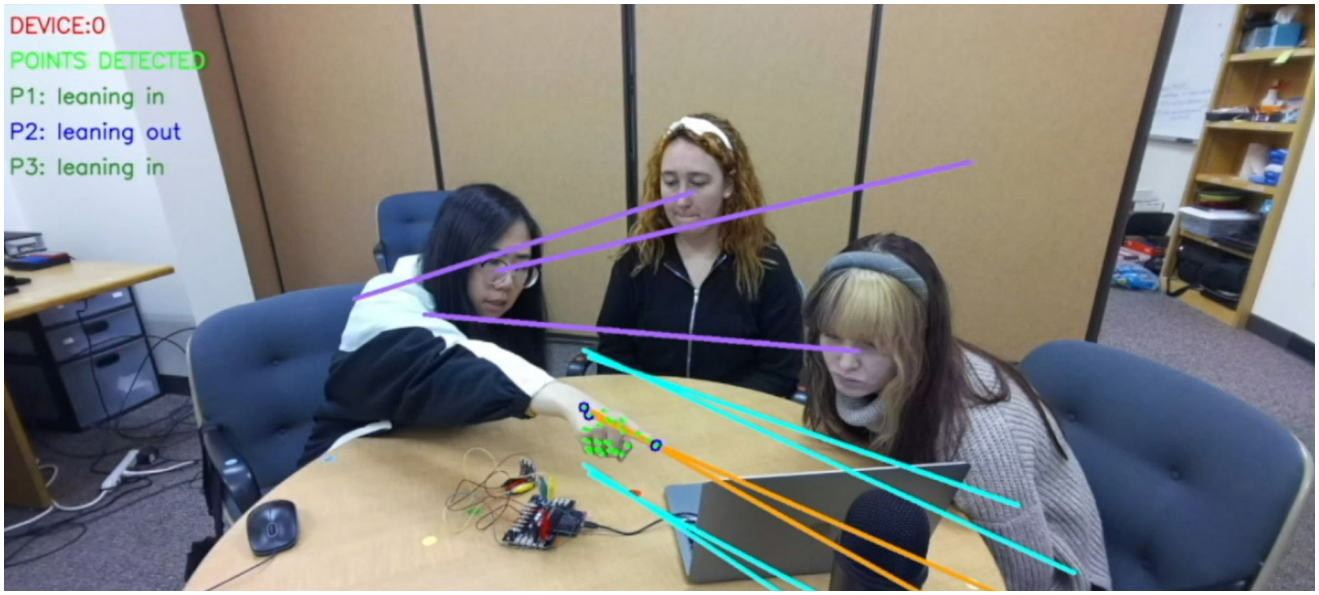
For the site visit demo, we presented our capabilities at detecting and tracking nonverbal behavior in student task oriented interactions in the classroom. We demonstrated capabilities for automatically recognizing the following behaviors in a noisy and dynamic environment: pointing detection, object recognition, gaze detection, object tracking, and body posture recognition. While these are all aligned with speech recognition, we focus only on nonverbal behaviors.

iSAT team members practice the Jigsaw Interactive Agent demo for the NSF site visit.

In turn, a member may at times be talking to their engaged collaborators about a solution that has stumped group progress for some time. Multimodal tracking and analysis can help ensure that an AI partner is intervening appropriately, rather than disrupting positive collaboration in the group.

We presented three scenarios, each illustrating a distinct set of challenges to multimodal analysis. First, we presented collaboration on the "weights" task with pointing object detection and gaze followed by two tasks from the SI curriculum illustrating posture and gaze.

In one example, we showed a group consisting of three members who work to solve a weights task—the Fibonacci series. One group member is tracked as not speaking during the entire interaction, as well as showing multiple lean outs, suggesting disengagement. Because of this, the system registers a change in engagement from high to medium. If this continues, it will drop further to low. Then, we showed a situation where the transcript is the same but the body language indicates much more engagement, demonstrating how important it is to recognize multimodal cues to determine social dynamics. Multimodal analytics are a critical component for an AI system that is intended to provide real-time interactive support; it needs to be able to recognize social dynamics for determining when it should and should not intervene.



iSAT team members demonstrate a collaborative activity with real-time multimodal analysis.

iSAT team members watching a live stream of the main presentations during the NSF site visit in May.

Feature: iSAT High School Internship Program

One of iSAT's guiding missions is to help grow the diverse workforce of the future. Alongside our pursuit of innovative AI education through AI-enabled curricula, our team has hosted the iSAT High School Internship Program since the spring of 2023 as yet another example of our commitment to the next generation of AI leaders. The program aims to enhance students' ability to envision, co-create, critique, and apply student-AI collaborative learning technologies both in the classroom and beyond.

In 2024, we expanded opportunities for interns at iSAT as well as helped them develop leadership skills by offering each intern the chance to complete independent research projects in any of our three main research strands (our plan for 2025 is to extend the internship to our Institute-wide track as well). This allowed the interns to choose the area of iSAT that best matched their interests and conduct targeted research projects under the guidance of an iSAT mentor.

Those who picked our Strand 1 mentor investigated AI biases and limitations: interns learned how to systematically "jailbreak" an AI system and elicit undesirable AI behaviors to shed light on bias, using approaches such as red-teaming and adversarial prompting. Strand 2's research project focused on application creation: a calendar app to aesthetically and functionally fit an individual's personality and lifestyle into a tracker app, which notifies students when there are no desk spaces available in a library. Notably, the Strand 3 project was based around iSAT's Self-Driving Cars curriculum (SDC): interns brainstormed different real-world implications and scenarios for self-driving cars, which have since been included as an additional resource in the associated teacher guide materials.

One intern summed up their experience by saying *"My experience with the iSAT internship was enjoyable and educational. The immense quantity of knowledge that I obtained during the internship will help me in my future endeavors, and my updated knowledge of AI, as well as the planning skills that I developed, will significantly assist me as I move forward through the modern, technologically focused world."*

Another intern responded similarly saying, *"My internship at iSAT taught me the fundamentals of what iSAT stands for and how our projects impacted the implementation of AI technology in education. It also helped me understand how AI is being used in everyday life such as in self-driving vehicles."*

To further hone their leadership skills, this year's cohort of interns organized and led two separate summer camp classes at one of iSAT's partner school districts. This consisted of the interns splitting up into two groups, Strands 1 & 2 and Strand 3, to develop a 4-day summer camp curriculum with the goal of immersing middle school students in the different topics of the iSAT Strands. The Strand 1 & 2 interns taught students about jailbreaking and algorithmic bias as well as the importance of User Interface and User Experience (UI/UX) of AI. Strand 3 interns taught students about programming and creating tracks for self-driving cars.

The summer camp attendees' final projects consisted of developing a concept for an AI classroom partner and explaining its UI/UX design including how to make it reliable and functional; another project involved the creation of a self-driving obstacle course including the programming of a self-driving car to complete that track. The camps had a great response—increasing the interns' ability to understand and create STEM curriculum and exposing even more middle-schoolers to iSAT's work. We look forward to building on this experience further in the future.

An iSAT intern working with Strand 2 presents research findings to the iSAT team.

Listen, Understand, and Connect

Strand 1

Strand 1 is guided by the foundational question: What advances in Artificial Intelligence are needed to facilitate collaborative learning conversations? The three research themes identified to help Strand 1 answer these questions are: Speech Processing & Diarization, Content Analysis & Dialog Management, and Situated Grounding.

Speech Processing & Diarization

This theme focuses on enabling iSAT's AI partners to reliably hear what all students in a group are saying. The team continues to make strides on improving filtering out unwanted noise from classroom audio. Several team members have been exploring how multiple modalities can increase the accuracy of Automatic Speech Recognition (ASR) systems by analyzing the visual content of what people are talking about in addition to how it sounds. One experiment uses a synthetic dataset of images (reminiscent of a sheet of paper on which a student is solving algebra problems) where each image contains three equations, and a person is reading out-loud two that are randomly chosen. The audio is noisy, which makes ASR difficult. However, by harnessing both visual as well as auditory information, the speech recognition model (Transformer decoder) can improve the ASR accuracy.

The researchers also extended earlier work done surrounding classroom instructional support using Large Language Models (LLMs) to estimate the amount of "instructional support" given by teachers to their students. In particular, the team devised a coding scheme for sentence-level annotation of "instructional support", and they are analyzing to what extent LLMs—with or without fine-tuning—can estimate the level of support automatically.

Over the summer, two team members traveled to Atlanta, Georgia, to attend the Educational Data Mining 2024 conference where they presented two papers: one on speaker diarization, and another on person re-identification for the classroom context. The paper titled "Speaker Diarization in the Classroom: How Much Does Each Student Speak in Group Discussions?" was awarded Best Student Short Paper.

Content Analysis & Dialog Management

This theme implemented a dialogue state classifier for the JIA Partner. This classifier, coupled with the Mistral based Response Generation, is currently undergoing Human in The Loop testing in the lab. The Content Analysis and Dialog Management team has also been working on Abstract Meaning Representation (AMR) graphs. Two team members attended the Uniform Meaning Representations (UMR) Workshop held in Boulder, Colorado, at the end of the UMR Summer School in mid-June. One team member gave the Keynote address—LLM Prompting Methods for Discourse-Level Graph Representations—and they both participated in a panel discussion about pipeline and end-to-end parsing approaches. Several team members worked together to create a document level AMR annotation tool as part of the CAMRA platform. This tool integrates multiple AI assistant models to enable annotators to efficiently annotate formal representations at the document level. The team is continuously refining the tool and conducting user studies to evaluate its innovative design and user interactions and the goal is to submit this work to two upcoming conferences. Another group of team members, who work on Dependency Dialog Acts and Annotation and Parsing, annotated and adjudicated the Sensor Immersion student conversations with Dialogue Acts. They are now expanding their annotation efforts to encompass a broader range of conversational genres, including text-based chats and collaborative gaming. The annotation and parser development efforts aim to provide the AI community and educational use cases in iSAT with a deeper understanding of conversational dynamics and a more comprehensive dialogue policy operational space. The team plans to release and publish their work at upcoming Natural Language Processing conferences.

Situated Grounding

Understanding the common ground that student groups establish when interacting with one another (such as their behavioral and verbal cues) as well as prior goals, expectations, and the beliefs they bring into the classroom, is the job of the Situated Grounding team. Common ground can be viewed formally as the degree to which the members of a community (or group of students, in this case) share their beliefs about various topics. To make this notion computationally tractable, the team limits the belief space of the students to those beliefs related to the curricular task the students are engaged in during class. The task is still challenging, however, since beliefs and doubts are conveyed through both speech as well as nonverbal behaviors in conversation.

This summer, the team optimized the recognition of the multimodal nonverbal behaviors that convey such information about a person's beliefs. Specifically, they improved the recognition and tracking algorithms involved in: pointing (deixis) and object detection of the target object; posture recognition of the students, indicating engagement or lack of engagement in the task; gaze detection at objects and other students, providing attention and co-attention markers. In addition, they synthesized these modalities together with ontic (real-world) actions in order to establish the dialogue-state based common ground of the cohort. These results were presented at a number of various conferences over the summer including the Human-Computer Interaction Conference (HCII) 2024 in Washington, DC and the 2024 Joint International Conference on Computational Linguistics, Language Resources and Evaluation (LREC-COLING 2024) held in Torino, Italy.

Orchestrating Effective Interactions

Strand 2

Strand 2 is guided by the foundational question: What advances in theories, interaction-paradigms, and frameworks are needed to orchestrate effective student and teacher interactions with AI partners? The three research themes identified to help Strand 2 reach this goal are: Dynamic Framework & Measures of Collaboration, Collaborative Learning (non-verbal and verbal communication; peer scaffolding), and UX Design & Multimodal Modeling.

Dynamic Framework & Measures of Collaboration

The team focused on two main projects over the summer. One study focuses on communicative collaboration and introduces real-time dynamic teaming metrics (reorganization of communication patterns) to integrate the first-person perspective with the Collaborative Problem Solving (CPS) coding perspective.

Second, several team members analyzed MakeCode data from the DataJam held in 2023—a workshop where over 20 team members convened to analyze the gaze, verbal communication, non-verbal communication in the datasets—to validate a multimodal influence metric that computes influence across eye gaze and communication data. The influence metric was correlated with socio-cognitive-affective (SCA) states (positively to cognitive load and negatively to positive affect) and CPS outcome of the MakeCode task. Exploring different influence calculations, the team found that within-person influence did not significantly differ from between-participant influence for predicting SCA and CPS outcome. While they found no significant differences between examining multimodal (speech, eye gaze) vs. unimodal (speech only, eye gaze only) influence, all results trended towards multimodal influence having more predictive power. Exploration of theoretical team cognition models and surrogate analysis indicated that multimodal influence is a dynamic interactive state that simultaneously predicts SCA and CPS outcome. They are submitting this paper to a special issue of Discourse Processes that focuses on multimodal CPS measurement from the 2023 DataJam.

Team members at the DataJam in 2023 came together to analyze gaze, verbal communication and non-verbal communication in data sets.

Collaborative Learning

This theme focuses on identifying verbal and non-verbal modes of collaborative engagement and identifying peer scaffolding moves, as well as understanding how peers support each other during collaborative learning.

The team has been dedicated to three tasks this summer. First, they have worked with other Strand 2 team members to annotate videos from iSAT lab studies to generate "collaboration states" based on the data. They have generated three states based on research in computer-supported collaborative learning (CSCL) which has (and will continue to) help guide the design of support in the Jigsaw Interactive Agent (JIA). Second, they examined how the annotations can support understanding of non-verbal communication during collaboration. To support this effort, they have annotated classroom videos to make decisions about the non-verbal behaviors that will be used to make decisions about collaboration. Lastly, team members worked on planning Community Builder (CoBi) studies in a new state in the midwest starting in the fall. They met with the new partner teacher and are excited about this partnership which will utilize CoBi for several weeks.

UX Design & Multimodal Modeling

The iSAT lab at CU Boulder has been busy conducting studies all summer long. Middle and high school students ages 12-17 years old volunteered to work with the JIA AI Partner and then provide feedback during focus group sessions. This first implementation of JIA in the lab has led to helpful feedback for the team. The current version of JIA being tested in the lab includes prediction of a group's collaborative states, a set of theoretically grounded rules that determine if an intervention is deemed necessary, and prompt generation using the Mistral LLM in development within Strand 1. Mistral sends a response for JIA, which is then evaluated by a human-in-the-loop (HITL) where the HITL is able to accept, reject, or modify the prompt before sending it along to the group. This evaluative HITL feedback is used to better inform the JIA backend. The iSAT lab continues to provide Strand 2, as well as the other strands, with valuable information in the development and updates to both of iSAT's AI partners.

Engaging Youth

Strand 3

Strand 3 is guided by the foundational question: In what ways can inclusive co-design processes empower stakeholders with diverse identities to envision, co-create, critique, and apply Artificial Intelligent learning technologies for their schools and communities? The research themes identified to help Strand 3 reach this goal are: Learning Futures Workshop, Games Unit, and Sensor Immersion/Self-Driving Cars Units.

In addition, leaders of Strand 3 have been putting a lot of effort into expanding iSAT's partnerships both within and beyond Colorado, to ensure that iSAT's curriculum and AI partners are being tested in classrooms that are racially and linguistically diverse. Several Strand 3 researchers have been in contact with different school districts. One in particular has expressed a strong interest in partnering with iSAT and has committed up to 15 teacher to participate!

Learning Futures Workshop

These workshops consist of diverse groups of high school students, resulting in crucial feedback from the participants on what they need and want AI partners to be able to do in the classroom. For the 4th annual Learning Futures Workshop held this past spring, the team shifted gears; instead of focusing on students, the goal of the workshop was to better understand parents' hopes and concerns around the use of AI in schools. To accomplish this, the team developed a series of so-called pláticas—focus groups that center relationship and trust-building through reciprocal sharing between facilitators and participants—with Spanish-speaking parents to explore their concerns and hopes about how AI is used within schools.

The team has spent the summer analyzing data, writing, and presenting research on how to create co-design contexts that support participants in envisioning possibilities for schools and AI outside the status quo of schooling. Additionally, the team attended the International Society of the Learning Sciences (ISLS) this year, where they presented their work on adapted conjecture mapping, a design tool to support educational designers in effectively and ethically enacting AI in classrooms. They also prepared and submitted two proposals for the American Education Research Association (AERA) conference, one that explores how to co-design emergent technologies and the other that explores how to create caring infrastructures that support the uptake of AI tools that support collaborative learning.

Games Unit

The Games Unit team guides the implementation of the Games Unit curriculum—a sequence of nine lessons designed to focus on teaching AI through investigating causes of bias in online gaming communities and what to do about it—as well as holds professional learnings for iSAT's partner teachers. With more and more teachers interested in implementing this unit, the team has been busier than ever. Over the last few months, the focus has been on revising the Games Unit to support AI partner integration, leading professional development in a new partner school district, and conducting analyses of the professional learnings. In addition, the team has been planning for supporting implementation in two new partner school districts this year.

In early June, the team made significant revisions to lessons in the Games Unit in order to support AI partner integration. These revisions included modifying lessons to support the community agreement building and revisiting routines as well as adjusting the jigsaw lessons to prepare for eventual integration of the Jigsaw Interactive Agent (JIA). They also focused on modifications informed by the Games Unit testing that occurred over spring in a new partner school district. Toward the end of June, the Games Unit team held a professional learning workshop to introduce seven teachers from a new partner district to the unit. These teachers represented a wide range of subject areas, including English Language Arts and mathematics, and grade levels (both middle and high school). The main goal of the professional learning workshop was to prepare teachers for the "triple challenge" of learning new content for themselves, a new instructional model (storylines), and integrating AI into their practice. A key design feature of this professional learning was providing structured time and processes to support productive adaptation of materials to fit teachers' disciplinary and school contexts.

The Games Unit focuses on Minecraft and Minecraft Education, pictured here, includes all the biomes of normal Minecraft along with the two different world-modes: creative and survival.

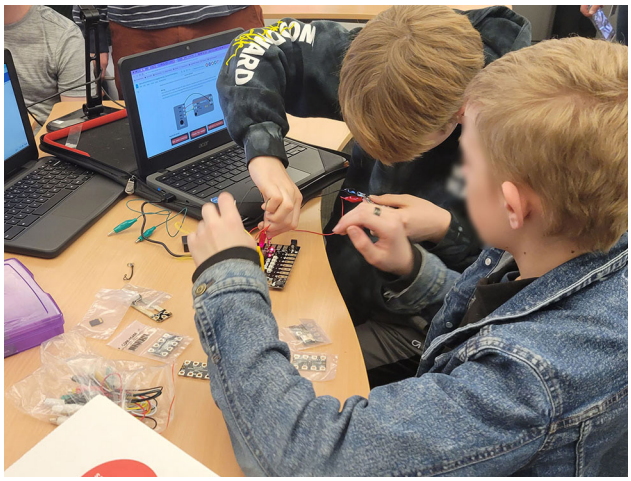
During the professional learning, educators engaged in different activities to help them reflect on the goals of

the unit and on their own readiness to engage students in conversations related to justice that are promoted in the materials. The Games Unit team is currently analyzing teachers' discussions of these goals, their understandings of equity and justice, and how these are or are not reflected in the adaptations they made to the unit. They also submitted a proposal to the 2025 AERA conference to present on these analyses.

The team is currently collaborating with the Institute-wide team to develop a JIA Partner that will be embedded within the Games Unit jigsaw tasks, lessons 3 and 4. They are actively scoping out the project space and planning for a v1 of the platform for integration this fall in a classroom of one of the teachers who participated in the summer professional learning. This will be the first time that a unit will have both CoBi and JIA partners integrated for classroom implementation!

Sensor Immersion

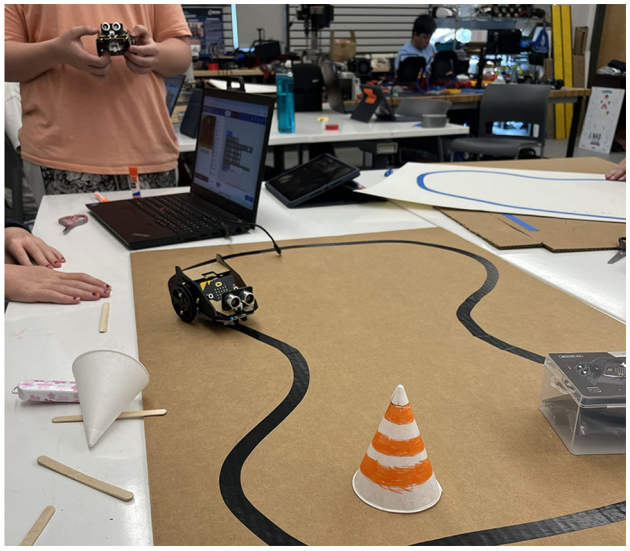
The Sensor Immersion (SI) team conducted an analysis of student performance tasks centered on STEM learning collected from classroom implementation of the unit. One key task involved evaluating what students learned from programming and working with sensors to investigate environmental questions. The assessment was designed to gauge students' grasp of essential engineering concepts outlined in the Next Generation Science Standards (NGSS). In this task, students were required to define a problem that could be addressed by programming sensors—one that they hadn't encountered before. This challenge tested their ability to apply the knowledge of sensors acquired during the unit to a new situation. The team's analysis of student responses revealed strengths in several areas: students effectively matched questions to the capabilities of sensors, defined criteria and constraints for solving the monitoring problem, and identified errors in programming. Moving forward, the SI team plans to revise their data collection protocols for the fall to gather more comprehensive data from student exit tickets and learning outcomes.



Students program and test hardware sensors to investigate local scientific phenomena.

Self Driving Cars

During the summer the Self-Driving Cars team focused on making revisions to the current curriculum along with providing a professional learning workshop to both new and returning teachers in one of iSAT's partner school districts.



Students participating in the Self-Driving Car Unit are seen here testing features they have implemented, such as line-following, obstacle avoidance, and switching modes.

One major revision to the curriculum centered on the addition of "unplugged" activities to help students gain insight on functions by practicing the concepts in group work and as a class. The students will use these functions —a foundational concept in computer programming — when they write code for the BitCars. The team made other revisions to the materials as well as the addition of an activity developed out of the family workshops held last spring to connect the phenomenon of self-driving cars to students' everyday uses of AI. They also revised the neural network activities and teachable machine instructions to make them easier for teachers to implement in classrooms. These revisions were based on interviews with teachers who had piloted materials in their classrooms last spring.

The professional learning workshop had a total of 10 teachers participate including three new teachers and seven who had already implemented the unit previously. The four-day event reviewed the storyline model of curriculum, immersed teachers in the launch and other lessons from the units and multiple in "learner hat," that is, as if they were students. Teachers had a chance to practice programming and also to engage with research on supporting student programming and investigations. They also learned about how to integrate CoBi into their classrooms.

Data Collection, Architecture & Implementation

Institute-wide

The Institute-wide team operates across the strands by providing expertise, resources (data, annotations, technology), and dedicated staff to ensure convergence of iSAT research strands. The four themes are: AI Partner Design, Implementation, and Testing; Classroom Data Collection and Coordinated Analysis, Technical Architecture, and Collaborative Problem Solving Framework.

AI Partner Design, Implementation & Testing

The Community Builder AI Partner (CoBi) focuses on the relationship dimension of collaboration. CoBi helps students to co-negotiate classroom agreements that reflect their idealized interactions with each other. CoBi then uses AI technologies to look for evidence of these agreements during small group collaborative learning.

After classroom testing and receiving feedback from teachers on the first version of CoBi last year, the team has conducted a significant overhaul of the CoBi user interfaces and user experience, particularly when it comes to elevating the middle phase as well as the revisiting interfaces and routines. The revised interfaces were then evaluated by members of iSAT's Teacher Advisory Board.

The new design implements features including using the navigation bar to allow users to cycle through (1) the Establishing view (remains the same), (2) a new "Live! View" for the dynamic tree visualization where the appearance of a new flower bud as well as its growth to a large flower is accompanied by a sound effect (which the teacher can mute if desired) and animated confetti, and (3) a selection of three tabs that open up different avenues for teachers on how to socialize CoBi's results with the classroom: celebrate, notice and wonder, and think critically. Each revisiting routine comes with a discussion prompt and sentence openers for students. The new interfaces have been included in the summer professional learnings held for teachers and the team is looking forward to seeing them in classrooms during the upcoming school year!

Classroom Data Collection

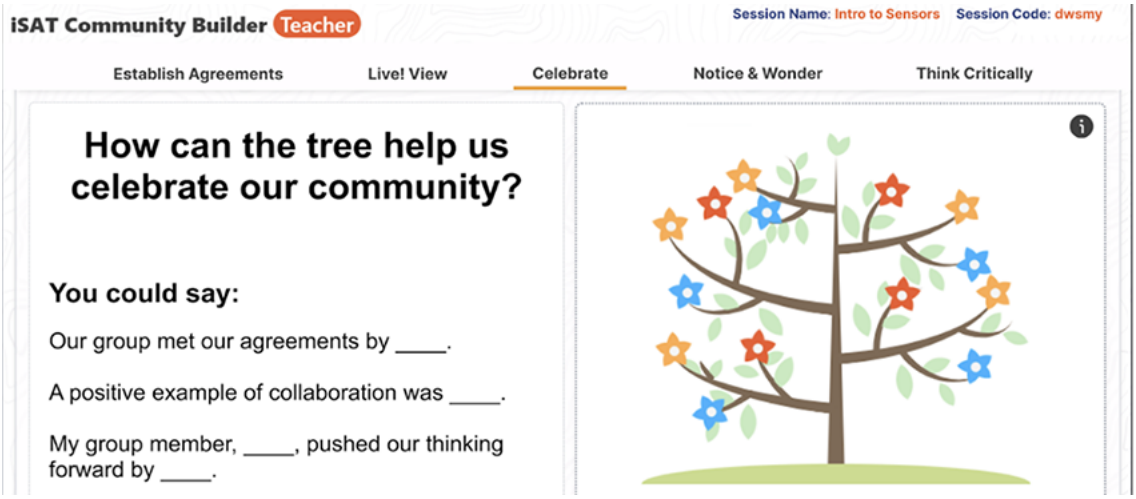
After a busy spring of data collection in classrooms, this summer the data collection team was hard at work producing datasets from classrooms that—for the first time—featured all three of iSAT's curriculum units: Sensor Immersion, Self-Driving Cars, and the Games Unit.

Specifically, the Institute-wide team along with the Sensor Immersion (SI) team implemented a pilot study conducted with CoBi, including an assessment of students' perception of collaboration and their STEM learning. This summer has been spent analyzing the data from the study, which was captured through automatic methods along with surveys. Their findings show that automatic Collaborative Problem Solving (CPS) coding is identifying more CPS-indicative discourse with each exposure to CoBi within the SI unit. Survey data show positive trends toward perceiving classrooms as supporting more resource interdependence, as well as students seeing their small groups valuing heterogeneity in collaboration.

Technical Architecture

The Technical Architecture team has made several significant additions and revisions to iSAT's AI partners and technology over the past several months. The CoBi AI Partner now has enhanced interfaces for students and teachers—incorporating prompts for reflection and discussion around the CoBi noticing and visualizations.

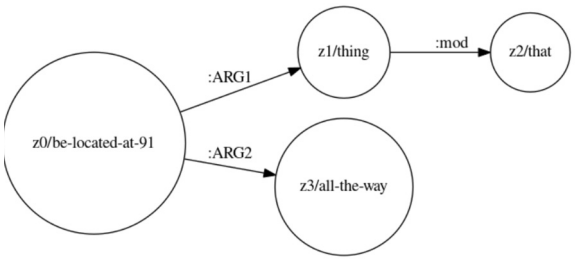
The team also designed a new browser-based curriculum and classroom management hub, which makes it easier for teachers to create and manage classes and sessions independently. This hub will be in the updated CoBi ver-



CoBi's improved interface helps teachers socialize collaboration with students.

school year. There have also been key improvements to the Speech Processing Pipeline in the following areas: In regards to Communicative Influence, the team implemented an improved influence analyzer and a line graph visualization that shows speaker influence over time, enhancing the display and capabilities of research findings. For Diarization Visualization, the team further refined this visualization tool showcasing the activity of individual speakers throughout a recording session resulting in speaker turn-taking data updating automatically as the recording progresses. The team members working on Abstract Meaning Representation (AMR) Analysis Display enhanced analysis data with a graph visualization, offering deeper insights into semantic structures.

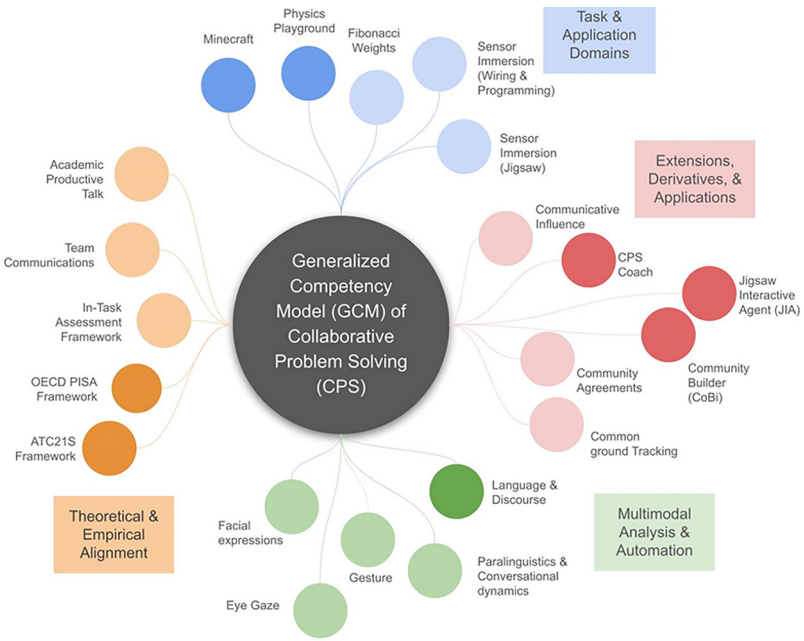
iSAT's second AI Partner, the Jigsaw Interactive Agent (JIA), also saw several updates over the summer. First, the web application user interfaces were updated to support direct agent-to-student messaging, Human In the Loop (HITL) messaging, and a baseline mode with no messaging. Second, the Multi-agent Architecture received an updated cloud-based architecture that supports multiple AI agents running in parallel, enabling the comparison of different agent approaches. The agents receive transcripts and analysis of student group interactions from the Recorder/Multimodal Intelligent Analyzer (MMIA) pipeline and generate messages to be displayed in the JIA HITL and student user interfaces. Three agents were implemented: two rule-based agents and a Large Language Model (LLM) agent. The team implemented a cloud-based Generative LLM API server using the Mistral Instruct mode, enabling the agents to incorporate generative dialog for the interactive AI partners. Lastly, in order to support interactive dialogue in JIA, the real-time recorder was updated and deployed on GPU laptops. The implementation uses Faster Whisper for improved responstimes and improved speaker diarization implemented with the ECAPA-TDNN model.



Abstract Meaning Representation (AMR) enhanced graph visulatization

Collaborative Problem Solving Framework

The team has been busy manually diarizing, transcribing, and annotating datasets for the Games and Self-Driving Cars units to investigate how students collaborate and to develop AI models of collaboration within these units for integration into the AI Partners. In parallel, the team has been working on a theoretical paper on CPS frameworks by first conducting an extensive literature review of the frameworks published over the past decade. They then conducted a theoretical and empirical integration of two recent frameworks in an attempt to prevent fragmentation of this nascent field of research. They also worked towards positioning the Generalized Competency Model (GCM) of CPS (developed by iSAT researchers) as a model of how a framework can be aligned to other theoretical approaches, adapted to new tasks, domains, and contexts, expanded towards multimodal signals including automation, and extended to new constructs and applications.



Centering the Generalized Competency Model (GCM) of Collaborative Problem Solving (CPS) within iSAT Research.

Member Spotlight

Learn more about our members!

Meet Jason Reitman—an Institute-wide Researcher who coordinates iSAT's data collection and annotation as well as heads up the lab study assessing the AI Partner CoBi's efficacy.

Q: What does your research focus on?

A: My research focuses on how we can measure teamwork and collaboration in how teammates talk. Can we use how teammates talk to each other to teach and support teamwork and collaboration skills?

Q: What is the coolest thing about your research?

A: Over the years, I've gotten to work with teams in sports, esports, academics, backcountry travel, and even farm- and trailwork. They each have different strategies for communication, but without fail, they all think about it with intentionality. Learning to communicate like an expert in any given field changes how you see the world and your team, and getting to learn from so many different kinds of teams has led to some of the coolest, most fun experiences of my life.

Q: What has been a turning point or defining moment in your career?

A: Like I mentioned, learning from the teams I work with is one of the coolest things I get to do. Getting to give back and teach them in return is one of the most rewarding feelings. The first time that happened in my academic career was when I was studying communications in elite esports teams in grad school. A coach asked how my research was going and we started talking about the kinds of communication practices their team was using and what kinds of changes they could try. They ended up implementing some of those ideas and went on to be one of the best collegiate League of Legends teams in the world that year.

Q: What do you like to do outside of work?

A: As I type this I'm thinking about the pattern for the sweater I'm knitting. When I'm not doing that I'm usually either building something as an excuse to play with new tools or relearning how to ski in the hopes of keeping up with my partner one day.

Meet Indrani Dey - a Strand 2 PhD student and Project Assistant who is advised by Dr. Sadhana Puntambekar. In her research, Indrani explores multimodal nonverbal indicators of collaboration.

Q: What are you currently working on?

A: I am applying the NICE framework (Nonverbal Interactions in Collaborative learning Environments) to lab and classroom datasets, to better understand what nonverbal interactions tell us about the groups' collaboration. I am exploring visualizations that capture these behaviors and provide meaningful insights on the groups' collaborative state. I am also working with researchers from Strands 2 and 3 to examine support moments in the classroom and in JIA studies.

Q: How does your research contribute to iSAT?

A: Examining students' nonverbal interactions provides a more holistic understanding of their collaboration. Identifying and examining group collaboration patterns may help us build better underlying models to identify their collaborative state and provide more targeted support.

Q: What is a fun fact about you?

A: I love finding new recipes (and food!) to try and I'm learning the guitar!

New Quarter, New Faces!

Growing our team and our impact

We're excited to welcome new members to our team! Some of our new faces include:

Emelie Rahn is a undergraduate research assistant with Strand 2 currently in her third year at CU Boulder where she is majoring in Data Science, along with two minors, Applied Mathematics and Nordic Studies. In Emelie's free time, she enjoys reading, playing video games and spending time with friends.

William Jones is an undergraduate research assistant with Strand 2 at the iSAT lab at CU Boulder where he analyzes collaboration data from students and teachers to foster equitable learning environments through AI. While pursuing a B.S. in Information Science, he contributes to iSAT's research by collecting and documenting classroom interactions. Outside the lab, he enjoys mountain biking and stargazing.

Brandon Smerchek is an undergraduate research assistant with Strand 2 at CU Boulder where he is pursuing a degree in Data Science and Statistics, along with a minor in business. Brandon is performing studies in the iSAT lab as well as organizing and managing research. In his free time, he enjoys mountain biking and spending time with his cat.

Zilong Li is a student researcher with Strand 1 at CU Boulder working on the AMR knowledge graph and the multimodality application. He received his bachelor's degrees in Japanese and history from Nankai University. He is now pursuing a Master of Science degree in Computational Linguistics at CU Boulder. Zilong's research interests include computational morphology, multimodality, and cognitive linguistics.

Welcome Emelie, William, Brandon, and Zilong!

Emelie Rahn
Strand 2
Reasearch Assistant

William Jones
Strand 2
Research Assistant

Brandon Smerchek
Strand 2
Research Assistant

Zilong Li
Strand 1
Research Assistant

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iSAT Publications and Outreach

Published / Accepted

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