FUTURE MAKERS

FUTUREMAKERS IMPACT REPORT

MIT | RAISE

in collaboration with SureStart

From project-driven learning to impact-driven learning & computational action

FutureMakers

Artificial intelligence (AI) is shaping our personal and professional lives. It is transforming industries as AI-powered applications, tools, and solutions enter the marketplace. It has already contributed to impressive economic growth, and organizations continue to harness it to help address society's most urgent challenges and realize exciting opportunities. However, if not designed and deployed responsibly, it can exacerbate inequity and cause harm, particularly to historically marginalized groups.

The goal of the FutureMakers program is to help to nurture and prepare the next generation of diverse AI-powered change makers who aspire to make a better world for all. MIT RAISE (raise.mit.edu) created the FutureMakers program to nurture early talent pipelines for a more diverse, creative, and ethical AI workforce for the future. To prepare students to be successful in an increasingly AI-powered world, the next-generation technical workforce needs to be trained to develop innovative solutions with AI responsibly. Others need to be trained to work with increasingly intelligent tools and technologies to become AI-enabled problem solvers and human-centered solution designers, bolstering their domain-essential skills and knowledge. In addition to understanding how AI works, they will need leadership skills, teamwork skills, creative problem-solving, critical thinking skills, and an entrepreneurial mindset.

Through this comprehensive program, FutureMakers systematically develops students' hands-on technical skills while also developing human-centered skills such as teamwork, leadership, entrepreneurial mindset, critical awareness, and responsible design methods of AI-powered solutions. It cultivates the formation of young people's computational identity and their confidence in digital empowerment. Computational identity encourages students to become leaders, learn how to design compelling solutions, and convincingly communicate their ideas for solving real-world problems that benefit others. Participants leave the program with a certificate of completion, practical technical skills, a compelling project with GitHub code, an enhanced resume, and improved interview skills that will help them secure their next summer internship, apply to college, or even make progress toward their own startup idea.

Figure 1: Components of the MIT RAISE FutureMakers Program.

Figure 2: Some of the students and mentors from our 2022 cohort.

PROGRAM DESIGN

FutureMakers is a no-cost six-week program designed to inspire and train diverse middle school, high school, and undergraduate students in AI technologies for positive impact. The program is run in collaboration with SureStart and is virtual by design to be able to eliminate barriers in geography and financial means to travel.

Students learn and work in a supportive online community of cross-grade peers, university student mentors, and FutureMaker staff. The cross-grade band teams encourage participants to be near-grade role models for each other.

In addition to the mentorship provided by the MIT RAISE and SureStart staff, FutureMakers also recruits and trains a diverse roster of university student mentors with expertise in AI and a passion for mentorship. These graduate or undergraduate students, or even FutureMaker alumni, also serve as aspirational role models for participants.

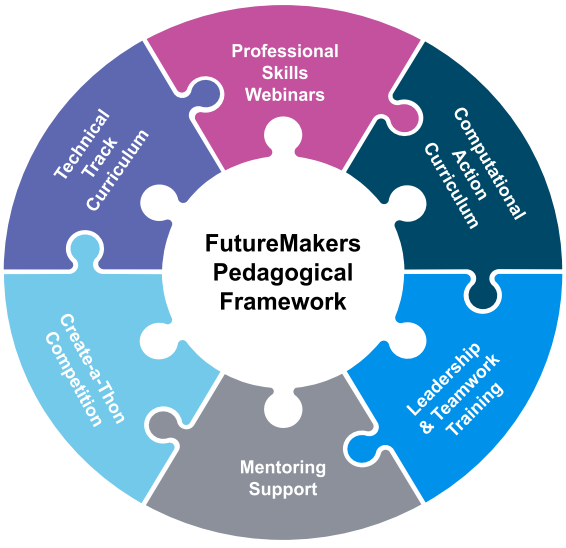
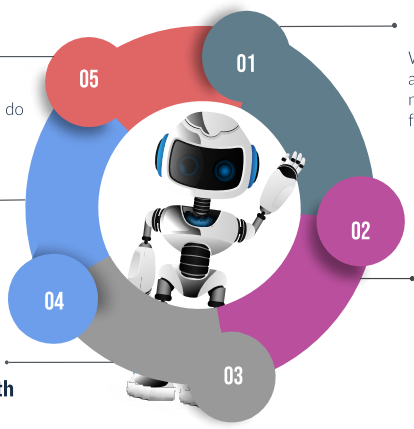


Figure 3: FutureMakers Program Components.

Students learn and work in a supportive online community of cross-grade peers, university student mentors, and FutureMaker staff. In addition to the mentorship provided by the MIT RAISE and SureStart staff, FutureMakers also recruits and trains a diverse roster of university student mentors with expertise in AI and a passion for mentorship. These graduate or undergraduate students, or even FutureMaker alumni, also serve as aspirational role models for participants.

The two-phase program is designed to holistically prepare students with technical, responsible design, and human-centered skills to empower them to become positive change-makers in their communities. To support this, MIT RAISE has developed a novel pedagogical framework and curriculum built on the principle of *computational action*, an **impact-driven learning approach** that empowers and encourages students to solve personally meaningful and authentic problems relevant to groups with whom they feel invested. This serves to further enhance students' own belief of self-efficacy and their confidence in tackling real-world problems that are personally meaningful. Finally, Futuremakers offers an extensive series of webinars featuring diverse industry experts to help students learn leadership and communication skills, how to interview and prepare a resume, oral and multimedia communication skills, and a wide variety of exciting career opportunities in the AI field.

THE COMPUTATIONAL ACTION PROCESS



1. Defining a real-world problem

What is a problem you want to explore? Who are affected? What currently exists and what is needed? Brainstorm ideas and seek inspiration from community and your passions.

2. Understanding users and communities

What does a day in the life look like for the user? What are their issues and concerns? Conduct user research with surveys and interviews to understand and validate your ideas for solutions.

3. Designing responsibly for and with users and communities

What are the key things you're creating? Design with users, wireframe, and rapidly prototype.

4. Teamwork, project management, and implementation

How do you keep on top of tasks and deadlines? Organize your project and team with the agile method.

5. Planning and making a long-lasting impact

What do you want to put into the world? How do you get it into the hands of people? Validating your project in the world with users.

Figure 4

Technical AI & Design Tracks. In the first four-weeks, participants learn technical skills and concepts in AI (such as deep learning, computer vision, or natural language processing) through lectures, hands-on exercises, and active mentorship. Currently, we offer two technical tracks:

- **DEEP LEARNING TRACK** for high-school and undergraduate students using Python. In this curriculum developed by SureStart, participants learn the tenets of machine learning (ML) principles, responsible design to mitigate potential ML bias, and hands-on examples of ML applied to affective computing, computer vision, natural language processing (NLP). They also learn about data analytics, visualization, and UI and responsive web design. They learn to use industry tools, libraries, and techniques including Python, Numpy, Keras, Github, Jupyter Notebooks and Google Colab. They use ML frameworks such as TensorFlow and explore Kaggle challenges using publicly available datasets that we provide.

- **MOBILE APPS & AI TRACK** for middle-school and high-school students using MIT App Inventor. To support novice coders in this track, MIT RAISE has developed student-friendly block-based coding tools with AI extensions to lower the barrier in making AI-powered mobile applications for Android and iOS. In this MIT RAISE developed curriculum, students learn how to code and debug their own mobile apps, as well as how manage projects with their team. They learn about machine learning, computer vision, and conversational AI through engaging, hands-on interactive tutorial examples. They are also introduced to free web-based UX design tools for designing the user interface of their app. Importantly, they also learn about highly consequential technologies, such as deep fakes, and understanding why the responsible design of AI applications is so important for society.

Figure 4. FutureMaker's computational action curriculum teaches participants practical skills such as brainstorming, problem identification, project management, market and stakeholder research, teamwork, human-centered design, user interface design, and responsible deployment and impact.

DESIGN JAMS. To help to reinforce students developing teamwork and computational action skills, we developed a series of short format mentor-facilitated design jams. In each, student teams are presented with a scenario based on real-life stories of youth around the world who have used MIT App Inventor to address a community problem (adapted from case studies published in *Become an App Inventor*, MITteen Press, 2022). Participants have 30 minutes to deliberate among themselves and, guided by their mentors, to come up with a "back-of-the-envelope" solution to the problem that they share out. Through design jams, students experience the pressure of a design effort in real life, where the time constraint forces them to rethink priorities together.

CREATE-A-THON COMPETITION. In the final two-weeks, students form cross-grade band solver teams with a dedicated mentor and enter into the Create-a-Thon phase of the program. The Create-a-Thon tasks teams to identify a problem in their community, design and prototype a human-centered solution with AI, and then present their solution in an entrepreneurial-style pitch competition to an expert panel of judges. Our unique computational action curriculum teaches students how to bring their idea from a concept to a well-conceived prototype solution with supporting tools and methods. Winning teams are awarded prizes that meaningfully advance their careers. Past winners have been awarded an all-expense paid opportunity to present their work in a special session at the ASU-GSV Summit (www.asugsvsummit.com) that "connects leading minds focused on transforming society and business around learning and work. Our north star is that ALL people have equal access to the future."

Figure 5. Example of a design jam scenario in the Mobile Apps & AI track.

Andres is a newly-arrived blind student in a large school in Seattle. Several of his classmates noticed he was having trouble finding his classrooms in between classes and decided to design an app that would help him navigate the hallways. GPS isn't available because there is poor reception inside the school and isn't very accurate. His new friend, Jaqueline, suggested an app that would read special signs on the ways and give audible navigaton instructions to Andres, as well as the location of stairs and other obstacles or hazards.

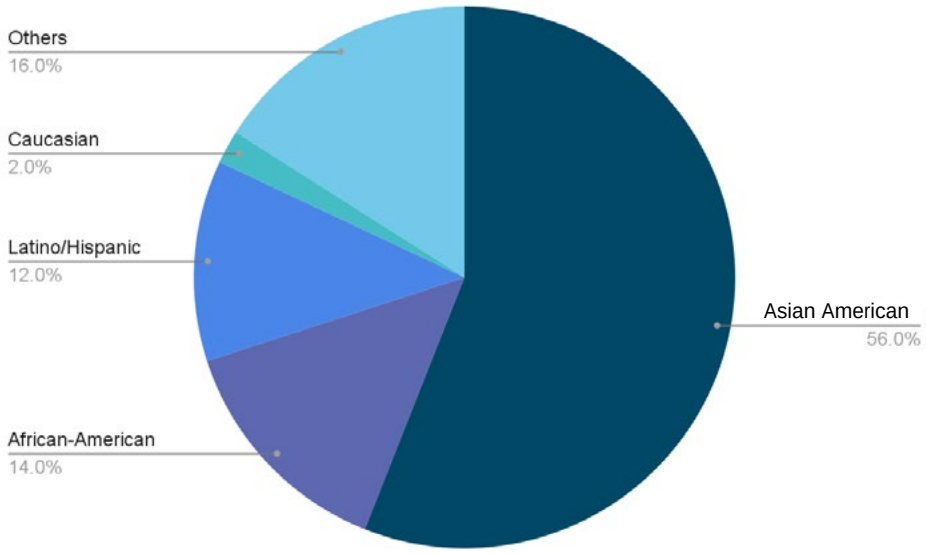
PARTICIPATION

Interested students apply through our online application. To make sure we are reaching under-represented and under-resourced students, we advertised our program through our growing email list of STEM non-profits and schools throughout the US. This includes organizations like the OK Thunder Fellows, Girls Who Code, Liliuokalani Trust, KIPP Academy, Computer Clubhouse Network, the Opportunity Network, and many more.

Over 350 students applied for the program, far more than the **84 participants** we were able to accommodate this summer, 2022. Our selection criteria balanced a number of factors, including our diversity goals, grade level, school district, whether the applicant attends a Title I school, and their answers to a series of short questions. We accepted a relatively gender-balanced cohort this year (45% self-identified as female). We also gave priority to students who would otherwise age out of the program next year. Qualified applicants who did not secure a spot this year may be prioritized next year. The distribution of the admitted students this year is as follows: 24% attend middle school, 52% attend high school, and 24% attend a college/university. Students hailed from 24 states and one US territory (Puerto Rico). A total of 33 participants were enrolled in the Mobile Apps & AI track. All middle school students (grades 6-8) and any student without any prior coding experience were assigned to this track. A total of 51 participants were enrolled in the Deep Learning track, all having at least a year of programming experience.

Essential to the success of FutureMakers is our high quality of mentors who work with participants throughout the program. We recruited 18 mentors mostly from undergraduate and graduate computer science programs in US colleges and universities (e.g., UC Berkeley, Cornell Tech, CMU, and Bowdin, to name a few). We strive for diversity in our university-recruited mentors: 65% of our university-recruited mentors self-identify as female, 12% identified as Latino-Hispanic, and 24% identified as African American.

We also included a few CS teachers from K12 school districts with whom we've worked in the past. All mentors received SureStart's "Mentoring Across Differences" training module to learn how to inclusively guide their mentees by providing constructive feedback, balancing accountability and encouragement, and supporting mentees who experience imposter syndrome. Deep Learning Track mentors were provided SureStart's asynchronous training materials on industry-focused machine learning. Our Mobile Apps & AI Track mentors received an intensive, two-week-long virtual workshop by MIT RAISE staff on MIT App Inventor fundamentals and its AI extensions (i.e., image classification, face segmentation, and conversational AI using Alexa). Over the 6-week program, our mentors delivered 18 hour-long head mentor presentations, 18 hour-long office hour sessions, and 540 team mentoring sessions.



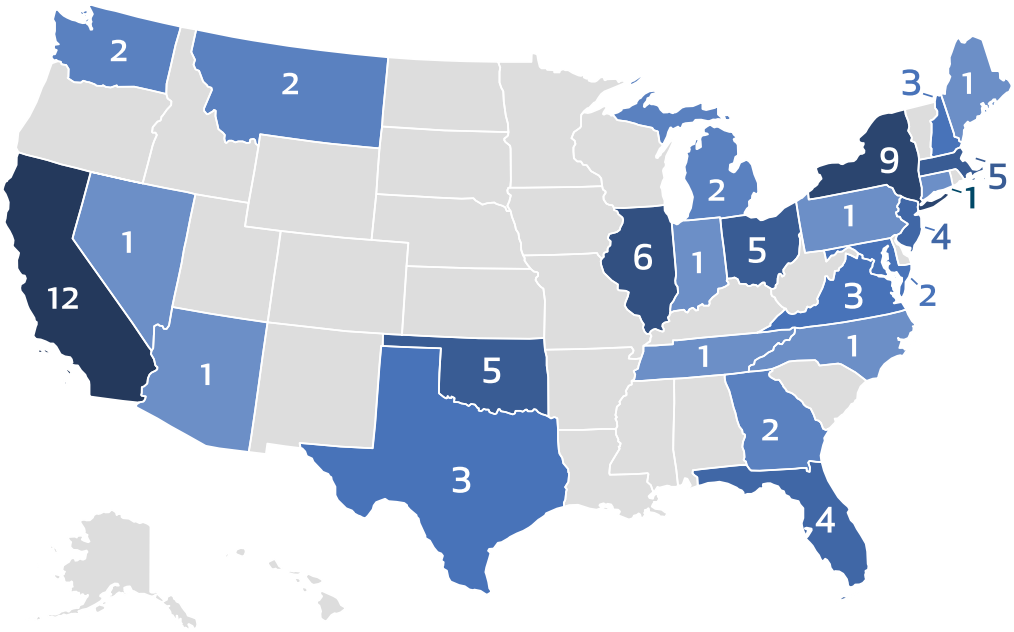
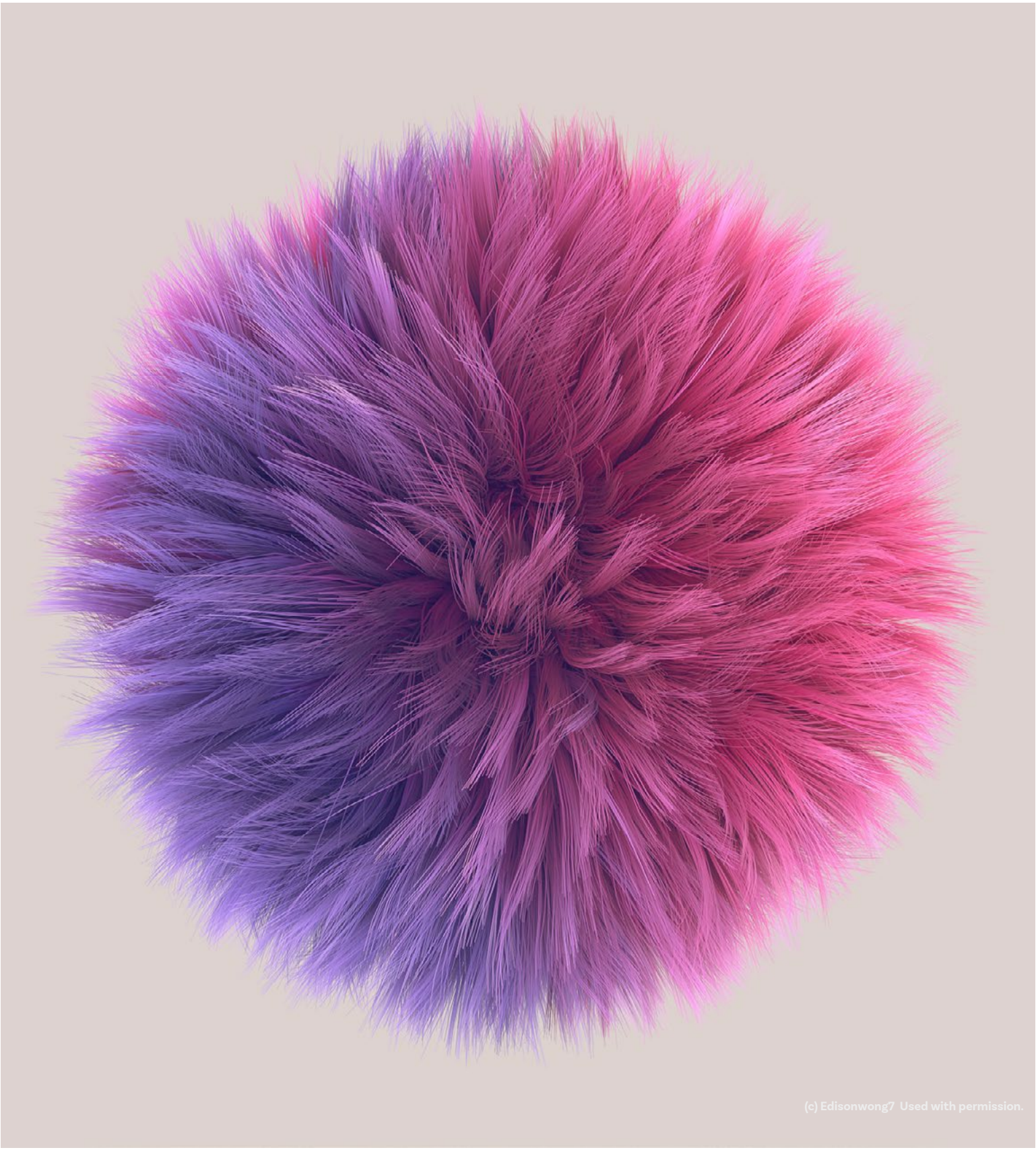


Figure 6. Distribution of the summer 2022 student cohort by race (top) and (bottom) geographic distribution across the U.S. Among our Asian American participants, 53% self-identified as female.

Just wanted to send my deepest gratitude to you both for allowing me to be a part of the FutureMakers Summer program. It was an awesome experience not just for me but the students as well.

LaKena W.
Programs Manager, OK Thunder Fellows
Tulsa, OK and Mobile Apps & AI Track mentor



FutureMakers was made possible in part through the generous support of:

DP World
MIT Open Learning pK12 Fund

The [MIT FutureMakers] program provides an opportunity for students from diverse backgrounds and educational profiles to gain an education in cutting edge machine learning topics. By fostering an open and inclusive educational environment, this program empowers its students to quickly and effectively cover a cutting edge curriculum.

Watching these students grow from novices to developing functioning machine learning projects that tackle real world issues is absolutely amazing. They gain invaluable self-confidence alongside an entirely new skill set. They become part of a larger community and grow alongside one another, fostering long term relationships that will certainly benefit them in the future. I look forward to seeing the amazing feats they accomplish in the future.

Kevin W.
PhD Candidate & Graduate Research Assistant at the City College of NY
Deep Learning Track mentor

IMPACT STORIES

The Create-a-Thon competition motivated students to apply technical knowledge and the computational action process to successfully prototype their proposed solutions with AI technologies to address a variety of social challenges across different applications. In total, 14 teams competed in the Create-a-thon and entrepreneurial pitch competition. There were 5 teams from the Mobile Apps + AI Track and 9 teams from the Deep Learning Track. Each team was assigned a mentor. Student solver teams were provided with open data sets and challenge prompts from the Sustainable Development Goals (https://sdgs.un.org/goals) to help inspire them. Table 1 summarizes the themes that the student teams selected and used their new technical, human-centered design, computational action, and entrepreneurial mindset skills to tackle.

The solutions and prototypes that teams presented were truly inspiring. In the Mobile Apps & AI track, teams developed and demoed working app prototypes. For instance, Team Bees presented a mobile app, *MReduce*, with a conversational agent to help farmers calculate the amount of methane gas produced on their farms to help raise their awareness and provide suggestions on how to reduce it over time. The winning team from the Mobile Apps & AI track presented a solution to help children in foster care report and combat abuse, and facilitate connecting them to qualified professionals (such as their assigned agent or the police) for help. The app included a mental health check-in that used affective computing to estimate the child's mood.

Table 1: Themes tackled by the student solver teams.

	DEEP LEARNING TRACK	MOBILE APP & AI TRACK
PHYSICAL HEALTH AND MENTAL WELL-BEING MANAGEMENT	3	1
NEW INCLUSIVE APPROACHES TO LEARNING AND WORK	1	1
TECHNOLOGY ENHANCED SMART CITIES	0	2
CLIMATE CHANGE AND ENVIRONMENTAL RISK MITIGATION	2	1
EQUITABLE RESOURCE ALLOCATION	1	0
ADVANCING SOCIAL AND RACIAL JUSTICE	1	0
ROLE & RELIABILITY OF SOCIAL MEDIA IN INFO SHARING	1	0

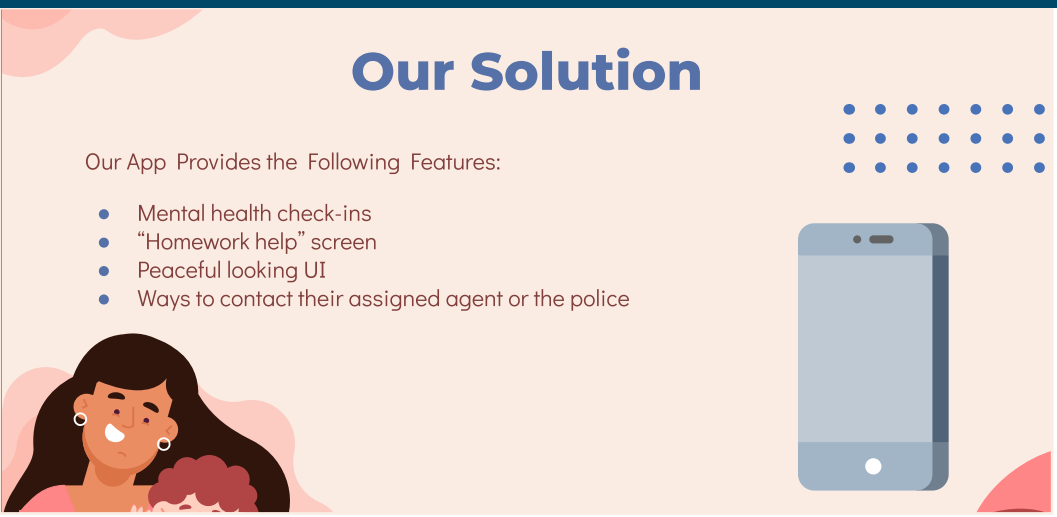
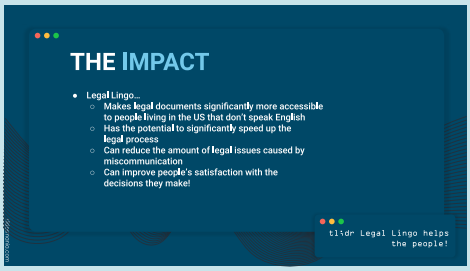


Figure 7. Team Pluthos and the value proposition of their mobile app, AIRE Foster Care.

Teams in the Deep Learning Track prototyped and demonstrated applications using trained models with open data sets we provided or that teams found online. For instance, Team CleanSea applied deep learning techniques to help clean up ocean environmental waste by making a cross-platform mobile app to prioritize cleanup initiatives by identifying, tracking, and predicting the trajectory of debris on the ocean surface based on satellite data. Team FumeFire developed a deep learning model and mobile app to help users predict the spread of wildfires in their area using geographical features and satellite imaging. The winning team, Team Lingo-quists, prototyped a web-based service, *LegalLingo*, to help translate legal documents into more easily understood prose, especially for people who are not fluent in English. The proposed translation service used DEEPL, a proprietary network architecture that automatically learns language translation using data acquired using web crawlers instead of the standard monolithic dataset.

Students expressed the uniqueness of the program in preparing them to tackle authentic problems with the use of AI knowledge, *"Although my team did not win the Create-a-Thon, the hours my team and I spent on our project and presentation only made us better programmers. Additionally, I learned that it is important to speak up and share ideas, as they have the potential to change the world."* In addition, students were able to develop foundational AI knowledge and skills, further strengthening their confidence in discussing and exploring advanced concepts in the field: *"I learned how to build, test, and deploy a machine learning model in a somewhat similar to real-world scenario."* Finally, students were able to develop the projects that made an impact in the communities, *"Anyone can innovate and build something amazing! A lot of technical skills were covered and taught in this program, and I was able to really see how those skills can be leveraged to do something meaningful for the larger community."*

Figure 8. Team Lingo-quists and the value proposition of their Legal-Lingo app solution.



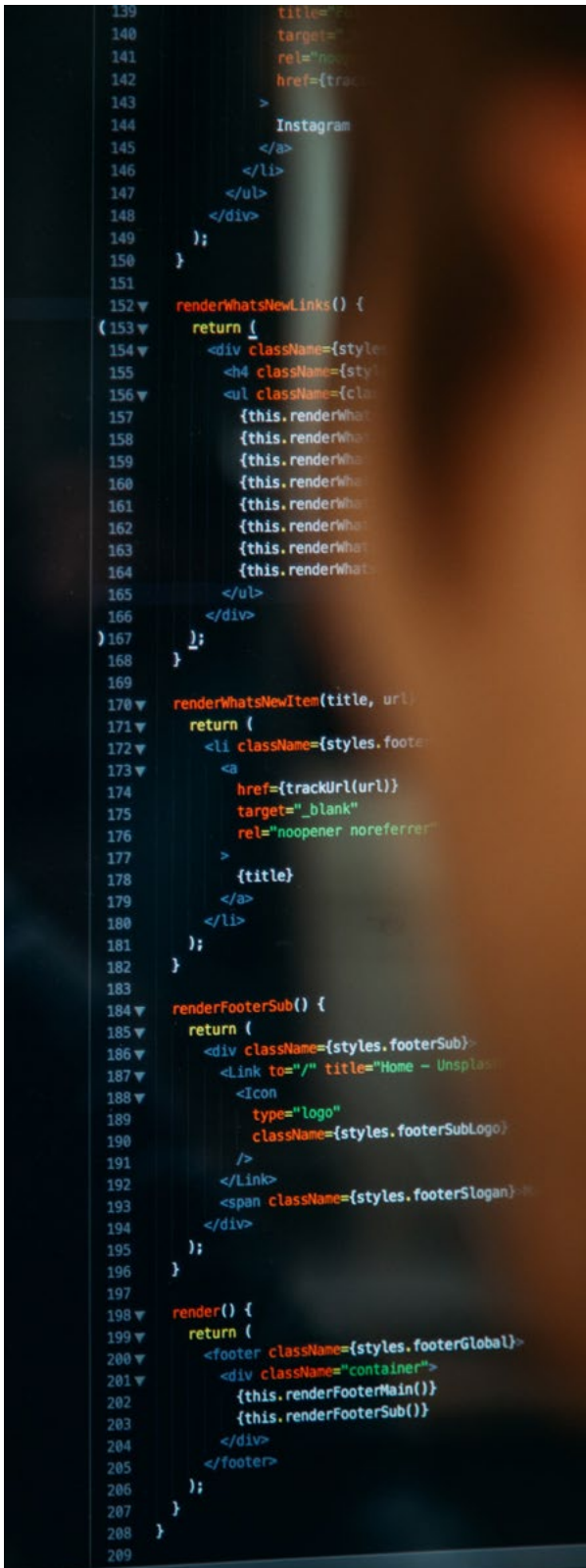
RESEARCH & EVALUATION

MIT RAISE conducts research and evaluation studies to iteratively improve the efficacy of our programs, as well as contribute to the science of new pedagogical approaches. Our 2022 study evaluated the effectiveness of our impact-driven learning pedagogy, manifested in our computational action approach, to positively impact participants' AI knowledge and skills and participant shifts in attitudes and perspectives to become AI-enabled problem solvers and change agents. In alignment with our program goals, we used a multi-cohort, mixed-method evaluation design for students and mentors. This includes pre/post changes over the program's start and end. We are also investigating the longer-term impacts of sustained interest in AI and CS of FutureMaker alumni at 6 months and 12 months after the program's conclusion.

A total of 83 students participated in the 2022 study, with 33 in the Mobile Apps & AI Track and 51 in the Deep Learning Track. All students were encouraged to complete the pre-post questionnaire, including both knowledge assessment and attitudinal questionnaire, to understand their knowledge development and perspectives on self-efficacy in AI, computational action, AI algorithmic bias, and social impact. Additionally, student and mentor interviews were administered to sample their overall program experience. Students' final projects were analyzed based on the project rubric to learn how students understand, use and innovate AI, especially with social implications, both positive and negative. Alumni from the 2021 program were interviewed to assess the longer-term impacts of the program.

Our intended learning outcomes and measures focus on developing students' technical content knowledge and skills in AI, building awareness and skills in the responsible design of AI solutions, and fostering the growth of their digital identity and digital empowerment.

- **AI KNOWLEDGE DEVELOPMENT.** Students from both tracks gained essential AI knowledge in App Inventor foundational

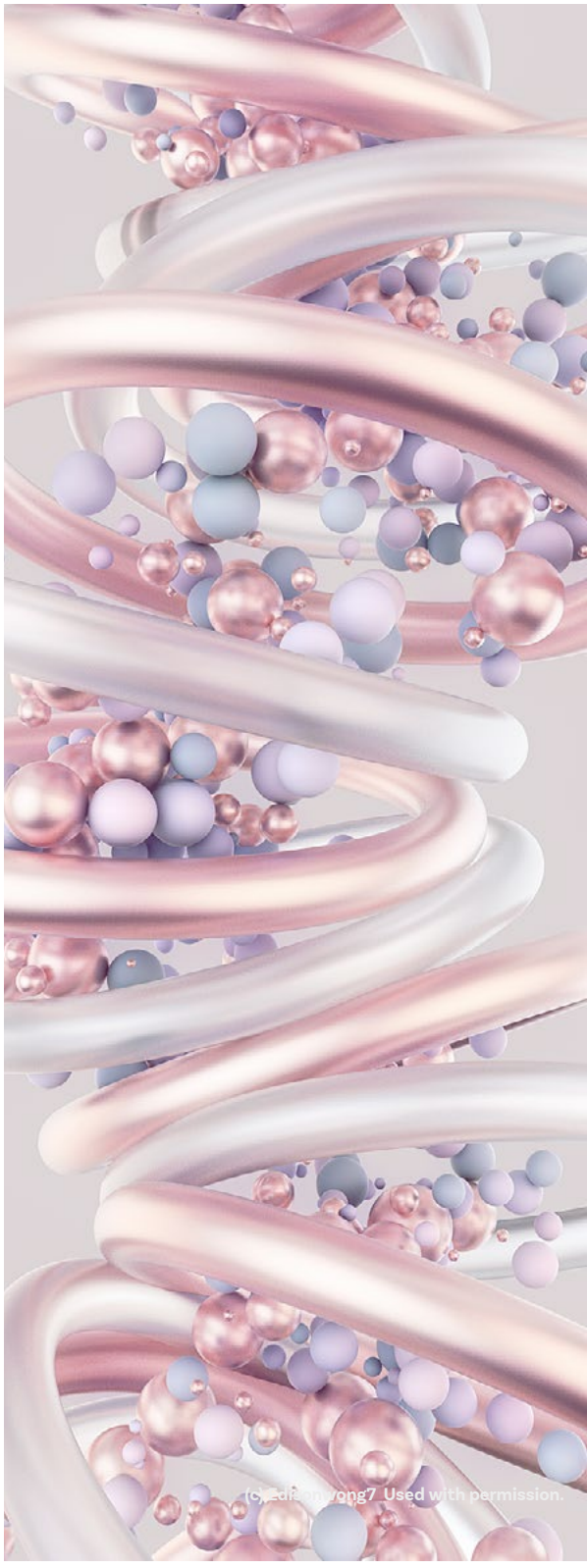


concepts and/or deep learning fundamentals. Analysis of our pre-post scores to assess student shifts in AI knowledge indicates an 8% gain in student mean scores of knowledge assessment improved in the Mobile Apps & AI Track with a medium effect size, and a 12% gain in mean scores from participants in the Deep Learning Track with medium effect size.

- **RESPONSIBLE AI DESIGN DEVELOPMENT.** We measured a positive shift in the areas of how students demystify the use of AI and ethics, which suggests students were able to develop a critical awareness of AI with its ethical and social implications. One of our participants said: *"I became more aware of how machine learning works, how to implement it in the real world, and the potential consequences of using this technology."*

- **DIGITAL IDENTITY.** Considering the awareness of computational action initiatives, students were able to formulate digital identities and learn how to propose their design solutions to solve real-world inspired problems responsibly. One of our students captured this eloquently: *"AI is [a] powerful and difficult tool to master, but with the right team of people you can implement a project with a lasting impact."*

- **DIGITAL EMPOWERMENT.** Students gained increased confidence regarding applying AI knowledge to solve a community challenge through the hands-on, highly-energized Create-a-Thon format. *"I really enjoyed the four weeks of self-paced learning, but I would have to say that building my own model with a team was the most exciting part. This program was genuinely such a good experience for me, and despite some things I think could be improved, I overall feel very positively about the FutureMakers experience."*



To understand participant team learning trajectories, the research team analyzed the final projects from the 14 teams based on their computational impact matrix. We found that student teams were able to successfully identify real-world problems, apply computational action processes to consider the ethical and social impacts of their projects, and apply their technical knowledge to prototype a solution to address the problem. Through the computational action-oriented process, students developed knowledge expertise and were able to effectively work in team-based online environments to tackle authentic projects that positively contribute to pro-social goals.

Select interviews from our 2021 cohort indicate positive longer-term impacts of the FutureMakers program on their continued interest in computer science. Alumni reported taking AP computer science courses, selecting Computer Science as their major in college applications, and securing summer internships to work at companies such as Lockheed Martin, WhatsApp, GE Appliances, and Walt Disney Imagineering.

In summary, our research findings suggest that our computational action approach is positively contributing to our participants ability to successfully learn about, critically reflect, and creatively apply knowledge in AI technologies within pro-social contexts. By engaging students in the action-oriented, team-based Create-a-Thon format, participants are able to frame, articulate, and prototype their proposed solutions to real-world inspired problems in an authentic environment. They are able to engage in peer-peer mentorship, receive constructive feedback from each other, design responsibily, iterate on their prototypes, and gain a sense of accomplishment with positive memories.

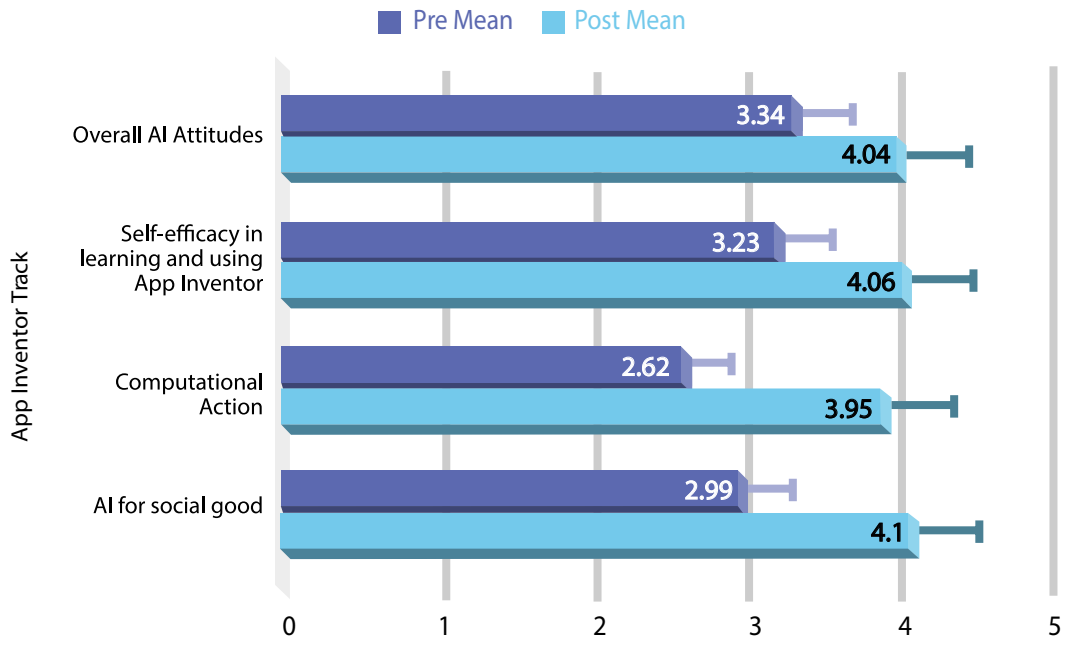


Figure 9. Mobile Apps & AI Track students' pre-post AI perspectives. Results from the pre-assessment (M = 3.42, SD = .91) and post-assessment (M = 4.04, SD = .61 indicate the effectiveness of Create-a-Thon in shifting students' overall perspectives in AI literacy with large effect size.

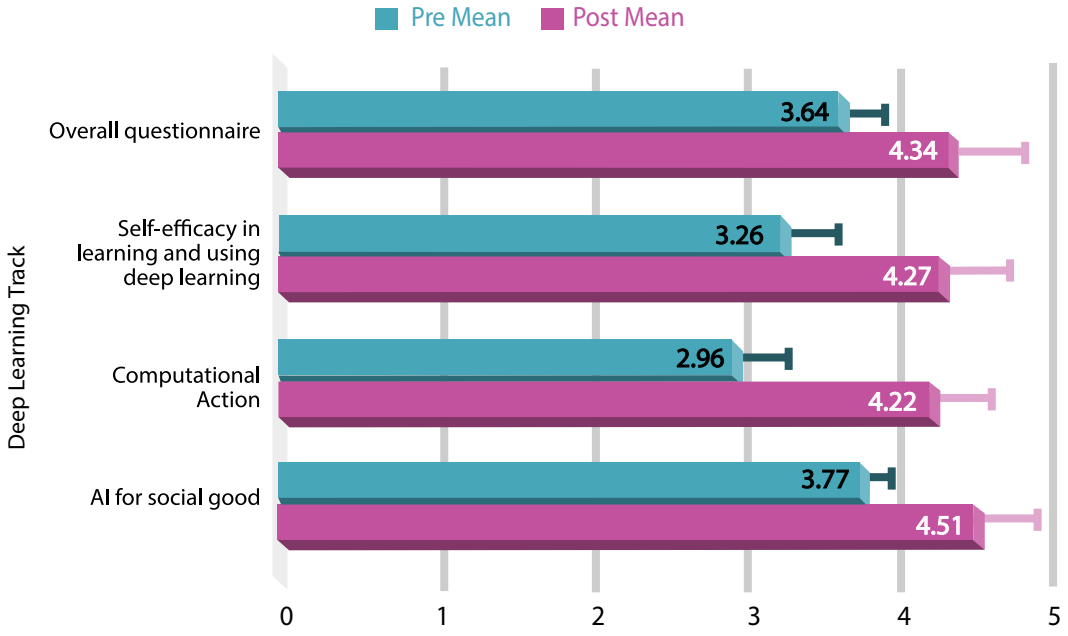


Figure 10. Deep Learning Track Students' pre-post AI perspectives. Results from the pre-assessment (M = 3.64, SD = .52) and post-assessment (M = 4.34, SD = .49) indicate the effectiveness of Create-a-Thon in shifting students' overall perspectives in AI literacy with medium effective size.

As an undergraduate, I was recommended to participate in the FutureMakers program where I was exposed to machine learning and artificial intelligence. I had the opportunity to connect with other students who share similar identities and experiences to me as a first-generation low-income student in the computer science space. The FutureMakers community allowed me to grow more confident and be proud of the work that I have accomplished by hosting seminars that go beyond the technical training as well as amplifying students who aren't generally recognized in the CS space.

Due to my success with my team in our AI capstone project, the FutureMakers program inspired me to continue nurturing my love for learning about CS by pursuing a Ph.D. in CS at the University of Denver. I hope to continue this relationship the FutureMakers program as they have helped me grow into a proud computer scientist.

Ericka C.
MIT FutureMakers 2021 participant
MIT FutureMakers 2022 mentor

SPONSORSHIP & HOW YOU CAN HELP

A generous grant by DP World supports our summer FutureMakers program. The inaugural FutureMakers program was launched in the summer of 2021 with 71 students and 21 mentors. In 2022, we held our second summer program with 84 students and 18 mentors. We intend to host another summer cohort in 2023.

FutureMakers is seeking support to scale our program beyond the summer session to accommodate more participants (students and mentors) across the US. If you are interested in becoming a sponsor, please contact us at futuremakers-info@mit.edu.

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ABOUT MIT RAISE

MIT RAISE (Responsible AI for Social Empowerment and Education) is an MIT initiative to innovate learning and education in the era of AI (raise.mit.edu). As computers continue to automate more routine tasks, AI education is a key enabler to future opportunities where success depends increasingly on intellect, creativity, empathy, and having the right skills and knowledge. In the face of this accelerating, AI-powered change to people's personal and professional lives, the RAISE research, outreach, and impact mission are to advance equity in learning, education, and computational action to rethink and innovate how to holistically and equitably prepare diverse K-12 students, an inclusive workforce, and lifelong learners to be successful, responsible, and engaged in an increasingly AI-powered society.

Headquartered in the MIT Media Lab, RAISE is a collaboration with the MIT Schwarzman College of Computing and MIT Open Learning. As part of the RAISE research effort, faculty, staff, and students from across MIT explore new pedagogical approaches, and develop a constructionist curriculum where students learn-by-making, creative innovative tools, advance the science of learning, as well as how AI can advance human learning. These advances are applied to RAISE outreach programs designed to promote an AI literate society by engaging teachers and students in impact-driven learning from PreK-12 to the workforce. The educational goals are to demystify AI and to enrich AI literacy for everyone by empowering learners of all ages to embrace AI technology creatively and to use it responsibly, equitably, and ethically. By doing so, we aspire for people to know how to use AI responsibly, have an informed voice to shape how AI is used in society, and prepare a diverse and inclusive workforce that can design and apply AI responsibly to make a better world.

ABOUT SURESTART

SureStart (http://www.mysurestart.com/) is a startup that provides flexible, accessible and industry-skills focused Data, AI and Machine Learning related skill-building programs for emerging technologists. Recognizing that the future of AI depends on inclusion and diversity – of ideas, skills, experiences, and perspectives – and its severe lack in the current AI landscape, SureStart is on a mission to increase diversity in the AI workforce through creating success pathways for career-aspirants from populations underrepresented in the tech and AI workforce. Our skill-development programs interweave learning of AI/ML and Data-related technical skills with the development of power skills critical for workplace success, situated in a mentoring-centered learning environment.

Founded in late 2020, SureStart has provided virtual industry-focused tech and AI/ML skill building "intensives" to 300+ students from diverse backgrounds, geographic locations and demographics, through collaborations with education and industry partners – 160 students supported in collaboration with our champion collaborator, MIT RAISE. Within months of completing our AI intensives, many of our trainees secured tech internships at companies like Amazon, Snap, Google, Microsoft, Accenture, Facebook, JPMC, Gap, Goldman Sachs, Consumer Reports among others. Looking forward, working together with current and new partners, we aim to scaffold the career pathways for not hundreds, but thousands of emerging technologists, to begin closing the AI diversity gap and make the industry more inclusive, and hence, more innovative and effective.

SureStart