Applied Machince Learning Bootcamps:

Confidence in Machine Learning

NACME

NATIONAL ACTION COUNCIL FOR MINORITIES IN ENGINEERING

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The National Action Council for Minorities in Engineering (NACME) was established in 1974 by a group of concerned business leaders to develop and catalyze a suite of strategies to increase the participation of individuals from populations that have been historically underrepresented in engineering, specifically Black/African American individuals, Hispanic or Latino/a individuals, and Native American individuals (sometimes grouped together as "underrepresented minorities" or "URMs").[1] In recent years, NACME has also expanded to include a focus on broadening participation in computing. Despite some strides, the challenge of diversifying the engineering profession remains—and has not kept up with the nation's demographic reality.

Introducing Applied Machine Learning Bootcamps

Computational engineering is a dynamic and rapidly expanding multidisciplinary field that harnesses cutting-edge computational methods to revolutionize engineering practice. In today's world, computational engineering plays a pivotal role across various industries, addressing critical design challenges with the power of advanced computing. However, equitable access to computer science, machine learning, and artificial intelligence education is not available across diverse groups, including those defined by race, gender, socioeconomic status, and geography.

The Google Applied Machine Learning (AMLI) Bootcamp - a groundbreaking eight-week summer program designed in collaboration with NACME and Google Education - is tackling this inequity by providing opportunities to underrepresented minority (URM) undergraduate students.

Since its inception in 2021, the Google AMLI Bootcamp, executed in partnership with public research-intensive universities - the University of Kentucky, the University of Arkansas, and Morgan State University - has made a significant impact. Empowering 121 historically underrepresented students with valuable knowledge and skills, the AMLI Bootcamps were offered using three delivered strategies: online-only, hybrid, and in-person platforms.

Independent of the delivery method, the program's core values remained unchanged - hands-on learning and professional development, all generously sponsored by NACME and Google Education. Moreover, students in the in-person module received comprehensive support, including full room and board, travel stipends, and computer science elective credits from their universities, making the learning experience truly immersive and transformative.

1 Underrespresented minority groups include Hispanic/Latinx, Black or African American, and American Indians or Alaska Natives. Diversity and STEM: Women, Minorities, and Persons with Disabilities. National Center for Science and Engineering Statistics (NCSES) 2023.

Race and ethnicity of the college-educated workforce, by S&E occupation: 2021

Of **Computer & Mathematical Scientists, 14.1%** come from underrespresented minority groups, with **8% Hispanic/Latino**, **6% Black or African American**, and **0.1% American Indian or Alaska Natives**.

Figures for **Engineers** are smaller with 12.1% from underrespresented minority groups, with **9% Hispanic/Latino**, **3% Black or African American**, and **0.1% American Indian or Alaska Natives**.

Diversity and STEM: Women, Minorities, and Persons with Disabilities. National Center for Science and Engineering Statistics (NCSES) 2023.

As we assess this empowering journey's outcomes, we discover its profound impact on our student's growth and development using pre- and post-assessments. The data presented here is for Summer 2022 and the 62 students participating across the three partner schools. At the start of the course, many students expressed little confidence in machine learning concepts like identifying bias in models and explaining its implications (*M=1.87*). However, as the program unfolded, we witnessed a remarkable transformation, with students' perceptions soaring to new heights (*M=4.05*). This significant increase in understanding bias in machine learning was no coincidence but rather a testament to the profound influence of the AMLI coursework. See Figure 1 for an illustration of the results.

Another fascinating concept that underwent a similar transformation was applying and tuning common machine-learning models in Python. Initially, students felt uncertain about their abilities in this area (*M=1.75*). Yet, after the AMLI Bootcamp, they emerged with newfound confidence (*M=4.07*). Such growth underscores the AMLI framework's power as an opportunity to shape young minds and prepare students for the future engineering workforce.

While celebrating these successes, we also recognize students' inherent strengths and enthusiasm for investigating, cleaning, and visualizing data (*M=2.85*). This passion for data analysis blossomed throughout the program, culminating in an impressive average post-assessment score of 4.15.

We extend our heartfelt gratitude to all our funders and executive stakeholders for your unwavering belief in the power of education, equality, and progress. Together, we shape a brighter tomorrow, where the spark of innovation knows no bounds and where the world of computational engineering thrives through the brilliance of diverse minds working in harmony.

The AMLI Approach + Framework

The Google Applied Machine Learning (AMLI) Bootcamp is a nationally recognized model to advance machine learning and AI knowledge and skills. It addresses inequities in computer science and AI education access for underrepresented minority (URM) undergraduate students.

Primarily serving the burgeoning community of African American male engineering majors, this trailblazing course ignites a passion for machine learning, turbocharging their credentials for sought-after roles as entry-level Machine Learning Specialists. The boot camp used a curriculum rooted in the engineering and computing education research literature. It gave our engineering majors the cutting-edge AI concepts and computational skills they needed to immediately impact the professional engineering landscape.

Here's a snapshot of the comparative analysis of student outcomes from our partner universities.

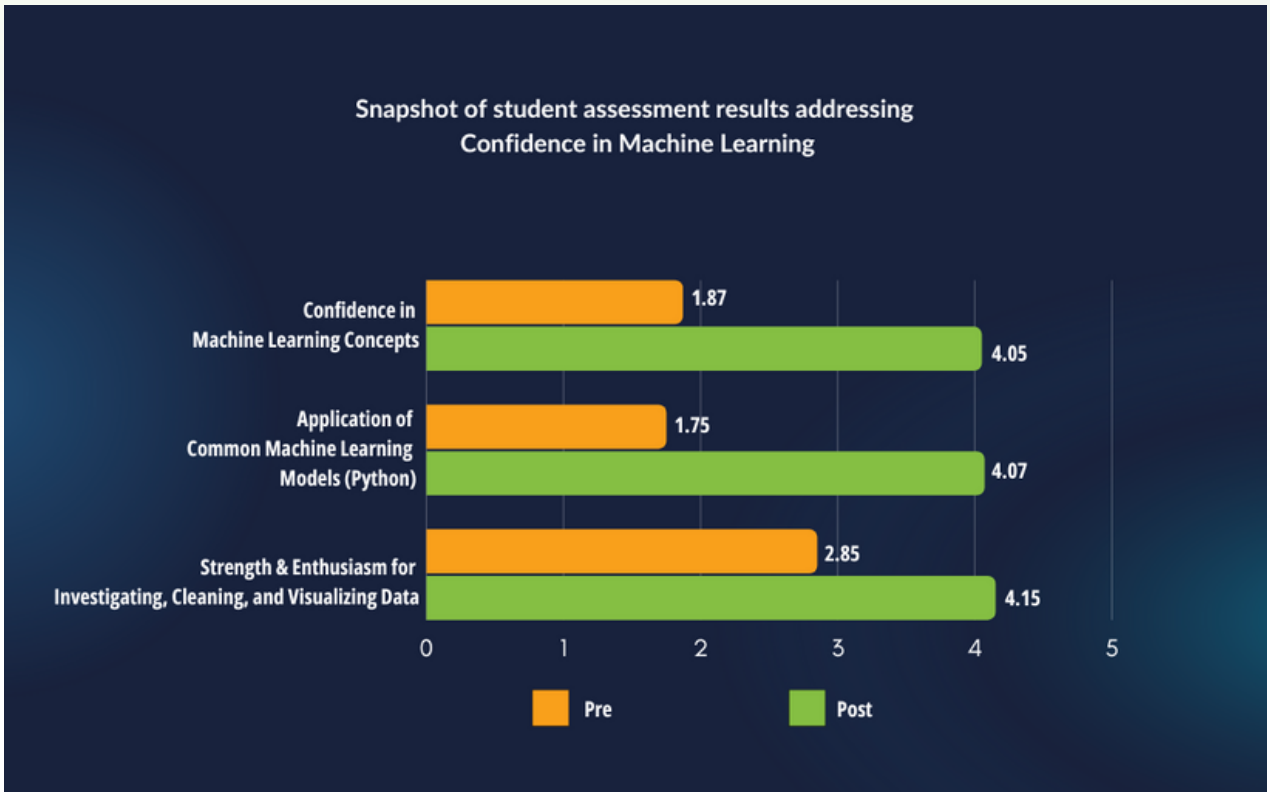

***Figure 1**: Data extracted from AMLI Reports by NACME; 2022.*

Before embarking on the course, our students faced several challenges. When asked whether they could "understand and frame a problem as a supervised machine learning problem," scores averaged from 1.67 to 2.24 across the three universities, demonstrating that students initially had limited capability in this area. Similarly, the capacity to identify and elucidate the implications of bias in machine learning models scored between 1.75 to 1.95.

When it came to applying and fine-tuning machine learning models using Python, the scores ranged between 1.67 to 1.86.

This initial assessment highlighted a crucial fact: our primarily African American male engineering majors felt underprepared to understand machine learning complexities, recognize biases, and implement machine learning models using Python.

Fast forward to the conclusion of the course, and the transformation is nothing short of extraordinary. The students' perceptions evolved drastically, gaining confidence in identifying and interpreting potential biases in machine learning models, with an impressive average score of 4.05. Their understanding and ability to frame a problem as a supervised machine-learning task also skyrocketed to an impressive average of 3.95. Most notably, they felt adept at applying and fine-tuning common machine learning models using Python, as seen by the high average score of 4.07.

This robust improvement, as evident in the post-course assessments, unequivocally underscores the massive influence of the Google AMLI Bootcamps. It acts as a beacon, enhancing underrepresented students' perceptions, confidence, and skills in the machine-learning sphere. With the continued support of the AMLI approach, we can keep breaking barriers and championing inclusivity and excellence in the exciting and ever-evolving realm of machine learning and AI.

Key Takeaways >>>

- **Positive Student Outcomes >>>** The AMLI Bootcamp has demonstrated significant positive outcomes for students, with notable improvements in their understanding of machine learning concepts, including identifying bias, applying machine learning models in Python, and analyzing, cleaning, and visualizing data.

- **Significant Skills Transformation >>>** The Google AMLI Bootcamp profoundly impacts students' understanding and practical application of machine learning and AI. After completing the course, students showed remarkable improvement in their ability to frame problems as supervised machine learning tasks, understand and apply common machine learning models using Python, and identify and articulate bias within these models.

- **Course Relevance to Workforce Needs >>>** The course's content aligns with the skill sets demanded in the modern engineering workforce, which is increasingly seeking professionals with robust computational skills. By imparting critical knowledge on machine learning and AI, the course bolsters the credentials of primarily African American male engineering majors, preparing them for roles as entry-level Machine Learning Specialists.

Increased Confidence among Underrepresented Students >>> The NACME Google AMLI course plays a crucial role in boosting the confidence of underrepresented students, particularly African American male engineering majors, in the realm of machine learning. Post-course assessments indicate a substantial increase in students' self-perceived competence, further cementing the program's significance in fostering diversity and inclusivity in the tech industry.

Let's Bridge the Equity Gap

The Google AMLI Bootcamp stands tall as a testament to the impact of collaboration and dedication in creating a more inclusive and promising future.

As evidence-based research advocates, NACME invites you to lend your expertise and passion to create a world where every aspiring mind, regardless of background, can flourish and contribute to the transformative landscape of engineering and technology.

By joining our collaborative efforts, you will play a pivotal role in designing and implementing programs that address the disparities in access, ensuring that every aspiring student, regardless of their background, has an equal opportunity to thrive in these rapidly evolving fields.

As you embark on this journey with us, your dedication will inspire countless young minds, ignite a passion for learning, innovation, and growth, and become a driving force in bridging the gap of inequity in computer science, engineering, and AI education for underrepresented minority undergraduate students.

Let's forge a path toward a more equitable and promising future in technology and beyond.

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