ADVANCING APPLIED TECHNOLOGY EDUCATION IN BIOMEDICINE THROUGH UNDERGRADUATE-LED COHORT-BASED TRAINING PROGRAMS

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Abstract

In the realm of novel technologies, the widening gap between public understanding and cutting-edge research presents a challenge for undergraduate training. Traditional curricula struggle to keep pace with the rapid evolution of technology, limiting the effectiveness of undergraduate education, especially for those aspiring to engage in professional-grade software engineering and machine learning projects. This challenge is particularly pronounced at the intersection of technology and medicine, demanding the cultivation of a diverse cohort across biological and technological disciplines. This paper outlines the approach of Medical Technology at Berkeley (MT@B), an undergraduate organization dedicated to fostering dialogue around medical technology through projects with companies and institutions such as Stanford Medicine, UCSF Medical Center, and Lawrence Berkeley National Laboratory. To address the educational gap, MT@B employs a two-part interdisciplinary program in a cohort-based setting. The New Member Training Program focuses on hands-on skills and group learning, while the Education and Mentorship in Biotechnology, Applied Research, and Knowledge in Medical Technology (EMBARK-MT) program delves into fundamental and cutting-edge topics like Software Engineering, Data Analysis, and Computer Vision for biomedical applications. MT@B's initiatives successfully integrate undergraduates into a technical environment, emphasizing collaboration and championing academic intersectionality. This streamlined approach aims to enhance the undergraduate experience by providing accessible, hands-on learning opportunities that bridge the gap between traditional curricula and the demands of contemporary technology and medicine.

Keywords: Technology in Medicine, Cohort-Based Learning, Medical Technology

1 INTRODUCTION

In the age of artificial intelligence (AI), the field of medical technology has witnessed a rapid evolution with novel medical informatics algorithms, data engineering techniques, and machine learning (ML) technologies. As the landscape of medical technology shifts to adapt to the growing development of AI/ML technologies for medicine, educational systems must adapt to accommodate the gap in existing educational programs for students who intend to enter a rapidly evolving industry.

Due to the extensive length of technology degree programs, there exists a significant barrier to entry into the field of technology research. This barrier is heightened in interdisciplinary technology fields, such as the field of medical technology, where there exists an even greater bottleneck due to the dual vastness of two intellectually rich fields. The most prominent issue facing medical technology research has been characterized as “insufficient communication from leading healthcare professionals regarding their needs for improving healthcare using AI technology innovations”[1]. Particularly for applied technology in biomedicine, where novel technologies such as ChatGPT[2], AlphaFold2[3], and MedPaLM-2[4] emerge frequently from ongoing research and rapidly change the scientific landscape, there is a failure of higher education programs to prioritize hands-on experiences with skills that transfer directly to multidisciplinary research and industry operations. For this problem of scientific literacy, it is imperative to train young professionals in applied technology to innovate across aisles while providing rich intellectual opportunities across both disciplines to inform their intersection.

To address this area of need in the medical technology ecosystem, Medical Technology at Berkeley (MT@B) pioneers undergraduate-led cohort-based training programs at the University of California, Berkeley (UC Berkeley). MT@B is a registered student organization (RSO) dedicated to fostering a productive intellectual dialogue across the intersection of medicine and technology. As a student-led

technology organization, MT@B cultivates future leaders across biological sciences, mathematics and computational science, engineering, and related disciplines to serve as assets to the organization's interdisciplinary workplace. To accommodate the highly interdisciplinary nature of medical technology as a field, MT@B cultivates an intellectually diverse organization that provides diverse educational opportunities with significant intellectual overlap across medical sciences, technology, and business.

With the goal of promoting close collaboration across subdisciplines of medical technology, MT@B operates in four intellectual areas, known internally as sectors: Medical Research and Development Sector (Med R&D), Incubator Sector, Infrastructure Sector, and Education Sector. The Medical R&D Sector focuses primarily on clinical outreach and scientific research related to medical technology. Students in this sector gain hands-on experience with clinical skills such as surgical knot tying and administration of medical technology including blood pressure monitors on patients. The core components of Med R&D are clinical volunteering and a physician-interaction project focused on elucidating the greatest inefficiencies experienced by medical practitioners to identify pathways for innovation in medical technology. To promote scientific communication, Med R&D members write scientific articles and literature reviews about medical technology research advancements and review scientific articles from members in other sectors of the organization. One such scientific article is "Unlocking the Tiny World of Microfluidics: Applications and Importance" by an electrical engineering and computer science (EECS) student in MT@B's Incubator Sector and one such literature review focused on the current state of neural prosthetic engineering research.

Led by an experienced Scrum Master, MT@B's Incubator Sector primarily consists of computer science and engineering students who develop client-centric technologies and spearhead their own technical and engineering projects. Incubator cultivates a research-centric engineering culture largely inspired by AI company Imbue[5] with Stand Ups, research paper discussions, Sprints, and line-by-line Code Reviews during weekly All-Hands work sessions. Among its three subsectors, Incubator's Consulting subsector develops applications for external clients from medical centers, research institutions, and industry companies including Stanford Medicine, UCSF Medical Center, and Lawrence Berkeley National Laboratory (LBNL). For scientists at LBNL, a team of developers from MT@B's Incubator Sector developed a Dockerized web application that applies a quantitative computerized tomography (CT) analysis algorithm in a containerized platform to automate traumatic brain injury detection for physicians. For physicians in Global Emergency Medicine at Stanford University, Incubator members on MT@B's Emerge Learning project developed a full-stack web-based educational platform that has been deployed internationally to train emergency medicine practitioners in countries with nascent Emergency Medicine Systems including India, Pakistan, the United Arab Emirates, and Kenya. Next, Incubator's software development subsector is known as the Developer Playground where students develop their own software and ML applications to interface with commercially available medical devices. In Developer Playground, MT@B's Chess for Brain Health project pairs a user's live chess gameplay with their biomedical data to infer cognitive health status using medical informatics techniques. The project analyzes decision-making strategy in a chess game by evaluating chess moves in a custom locally-hosted graphical user interface (GUI) developed by Incubator members specifically for the project. Through the chess GUI, Chess for Brain Health incorporates analytics of chess strategy with analysis of biomedical data from a chess player's wearable Apple device to quantify cognitive health status. Finally, Incubator's Makerspace subsector leverages MT@B's partnership with Berkeley's Health Tech Colab for mechanical and electrical engineering projects. MT@B Makerspace engineers build physical devices including programmable microfluidics and electroencephalography (EEG) devices in the Health Tech Colab's private on-campus workspace.

The Infrastructure Sector manages business operations including finance management, public relations, partnerships, client project sourcing, and personnel recruitment. Infrastructure networks with professionals at external medical technology organizations such as Johnson and Johnson, Mayo Clinic, Cleveland Clinic, and Kaiser Permanente. Infrastructure manages collaborations with MT@B alumni at institutions such as Yale Medical School who serve as mentors for pre-medical MT@B students and with cross-collegiate organizational partners such as Oxford University's student neurotechnology research organization, known as OxNeurotech. To foster a strong educational culture, the Education Sector leads all educational and training programs for members to establish strong foundations in both biomedical sciences and technology as preparation for client projects, academic initiatives, and self-driven research projects.

Due to the academic diversity in its organization, MT@B educational programs span many intellectual domains and skill areas to provide a broad reach with its educational programs. As an organization

meant to train future professionals across a variety of roles in medical technology, MT@B provides a dual-pathway education program to UC Berkeley students known as the New Member Education Program (NMEP). This paper details the specific approach of NMEP as an undergraduate-led cohort-based program with two parallel educational curricula for students to efficiently gain proficiency in critical skills for medical technology research and innovation in industry.

2 METHODOLOGY

2.1 NMEP COHORT-BASED TRAINING PROGRAM

NMEP is a student-led cohort-based educational program which provides a hands-on skill-based education to close the gap between traditional undergraduate curricula and professional requirements of the medical technology industry. Operating on UC Berkeley's academic semester system, MT@B admits applicants in the first month of the semester to start in NMEP or join a project directly. MT@B administers the NMEP training for the length of one academic semester to the most recently admitted batch of new members who serve as one NMEP cohort.

To accommodate the diverse operations and intellectual pursuits cultivated by MT@B members, NMEP is geared towards a cohort of new members from a diverse set of academic backgrounds. The core pillars of NMEP are to introduce students to the field of medical technology, prepare students to contribute substantially to internal projects across all four sectors and foster a strong and healthy cohort. Past iterations of MT@B NMEP and similar instances of undergraduate-led cohort-based educational programs have demonstrated significant success when accompanied by a tight-knit cohort of students. Most cohorts of new members are primarily composed of first and second-years, for whom NMEP provides educational opportunities and a social network.

Cultivating a healthy and connected cohort can be challenging due to the simultaneous exposure to challenging course material. It is for this purpose that one or more designated NMEP Course Coordinators serve efficiently to manage cohort dynamics and encourage discussion among students. Every week, NMEP meets for a 10-minute discussion activity led by Course Coordinators, followed by a 50-minute lecture on the topic of the week and a 30-minute hands-on activity or technical implementation for students to complete in groups. Course Coordinators account for the differing skill levels of incoming students and make sure that the groups contain members of different backgrounds to facilitate diverse thought and genuine discussion and engagement. At the end of the lesson, students complete a short quiz, referred to as a "vitamin", to evaluate their understanding of the content taught.

At the end of the course, students complete a final project, taking what they have learned in NMEP to then develop a product or proof of concept that incorporates topics taught in the prior weeks. Final projects are presented alongside MT@B client projects at an organization-wide banquet at the end of each academic semester. At its core, NMEP provides a network of peers to securely connect students with their cohort members and with their Course Coordinators who provide a foundation of social cohesion. Within NMEP, students experience academic, intellectual, and professional enrichment through one of two educational programs: Education and Mentorship in Biotechnology, Applied Research, and Knowledge in Medical Technology (EMBARK-MT) and InnovationRx.

2.2 NMEP: EMBARK-MT PATHWAY

The EMBARK-MT program component teaches fundamental and cutting-edge topics like Software Engineering, Data Analysis, and Computer Vision (CV) for biomedical applications. While all EMBARK-MT students have prior programming experience, many have never written code within the context of an industry or research-grade application. For underclassmen who join MT@B with minimal prior software development, information technology, or biomedical science experience, EMBARK-MT's curriculum facilitates technical skill-building and cultivates confident future contributors. At the end of the semester, EMBARK-MT has an open-ended project, allowing students to work on something that sparked their interest throughout the course or create a new lecture or lab to potentially add to the curriculum. Doing this gives them the opportunity to work on an unstructured project and create their own solution to a problem. Or if they are interested in potentially working in our Education sector, we allow them to contribute to the course and make an impact for future students.

Our curriculum consists of a multifaceted education designed to equip students with a nuanced understanding of medical technology and a practical skill set that is essential to an ever-changing healthcare technology landscape (Table 1). Beginning with an introduction of what medical technology is along with some important names and companies in the space, the course offers a foundational understanding of the industry. This module also delves into some fundamental biological concepts such as the Central Dogma Theorem and provides a contextual framework for future lessons on medical specialties, anatomy and organ systems, and the types of medical data. Moving forward, the course moves into the technical side of the field traversing essential computer science and software engineering basics. Here, students engage in the application of collaborative tools like GitHub, fostering an understanding of efficient code management, modularization, and teamwork which is essential in future projects. Informatics basics form a critical cornerstone, offering a robust toolkit for various data analyses. Learning programming tools like Pandas, Numpy, and Matplotlib enables the exploration and visualization of complex medical data. Students then dive into classic and research-oriented ML techniques, emphasizing their applications in medical contexts. Moreover, an understanding of hardware fundamentals such as the anatomy of medical circuit boards and specific devices in the field helps to bridge the gap between theory and practical implementation.

2.3 EMBARK-MT: MACHINE LEARNING CURRICULUM

As applied technology in biomedicine has been monumentally impacted by the rise of AI/ML technologies, EMBARK-MT heavily emphasizes ML fundamentals and practical skills with a specialized ML curriculum to adequately represent the current landscape of medical technology. Sequentially throughout the course, students are introduced to increasingly more complex ML technologies that have become critical in the medical technology space, starting with CV and progressing to natural language processing. First, an in-depth exploration of Convolutional Neural Networks (CNNs) empowers students to comprehend, segment, and analyze images using the CV pipelines and packages that researchers use on a daily basis. This is followed by an introduction to various scanning and imaging technologies, along with the differences in resultant medical images. Finally, this knowledge is tied together in an introduction to digital pathology, applying CV to the field of medicine. With a solid foundation in CV, EMBARK-MT's ML curriculum moves towards teaching how large language models (LLMs) work, starting with instruction on the attention mechanism and the encoder-decoder foundation of large language models using the paper "Attention Is All You Need"[6], MT@B's ML curriculum applies LLMs to the medical technology field by discussing medical chatbots such as MedPaLM-2[4], BioBERT[7], and Med-LLaMa2/ChatDoctor[8]. Finally, EMBARK-MT explores the MSA transformer[9], using NLP to predict phylogenetic alignment of biological sequences such as DNA , RNA, and proteins. Using open-source resources from AlphaFold[3] and ColabFold[10], the course provides hands-on experience with contact prediction and protein design.

A crucial aspect of EMBARK-MT's ML curriculum is that students are taught theoretical aspects to solidify their understanding, such as mathematical formulas behind ML models. However, equally important, EMBARK-MT supplements teachings with more practical skills, like learning to write code that can run these models. This dual approach not only provides members with concepts to spur their creative thinking but also equips them with the tools to implement and test their ideas. Many resources currently available can be either too general, such as undergraduate Artificial Intelligence coursework, or highly specific at the cost of failing to properly explain underlying concepts. By carefully designing lecture content that builds off of students' existing skills with linear algebra, calculus, and coding, EMBARK-MT is able to bridge the gap between concepts taught in class and those applicable in the real world. Additionally, content continuously builds off of previously learned material, allowing lecture material to progress toward covering more advanced image processing techniques and architectures. Instead of using textbooks or readings, the course aims to leverage recently published open-source repositories from novel research to teach students over textbooks[10]. This approach reinforces the lessons in the lectures and allows students to practice hands-on what they have learned.

One of the most pressing issues in ML is that it is difficult to understand when to use certain models, which parameters to use, and how to manage data [11]. While some is learned through class content, much is explored through trial and error and recognition of emerging patterns. Accordingly, a guiding principle of EMBARK-MT's ML curriculum is that instead of focusing on what these models are composed of, students learn specific scenarios where certain models and relevant hyperparameters should be used. Research projects also provide insight into the practicalities of ML algorithms. Many projects describe the challenges faced when moving from theoretical models to running them on-device. Issues such as lack of training data, computational power, and disparities between

simulations and the real world must be taken into account. Other traditional ML models such as clustering, K-nearest neighbors, PCA, and decision trees (Fig. 1) offer a peek into the numerous techniques applicable to medical datasets. This repeated style of focusing on how theoretical skills can be applied to real problems contributes to the success of EMBARK-MT.

EMBARK-MT students are consistently updated on current areas of focus in medical ML research and ongoing research projects in the medical technology field. Within medical CV, this includes CV-Based Sign Language Detection, Vision Correcting Displays, and Assistive technologies for Human Computer Interaction (HCI)[12]. However, staying up-to-date with cutting-edge research presents its own unique challenges due to the use of highly technical language that presents a barrier for newcomers from understanding the full technical depth of a scientific research paper. Our methodology to increase the approachability of papers is to break complex research ideas down into smaller building blocks while maintaining a high academic standard. Rather than reading papers on their own, students have the opportunity to have their specific questions directly addressed and immerse themselves in academic vocabulary. Learning about these projects encourages students to pursue their own ideas, join the several research organizations on campus, and transition towards Incubator projects and Medical R&D research applying their new knowledge. Additionally, creating an academic culture that encourages consistent discussion about current research ensures that students are knowledgeable regarding state-of-the-art techniques and prepares them to tackle modern problems. By learning highly technical language and research analysis skills, students are primed to sustain their research interest in medical technology outside of MedTech with highly developed research skills.

The final component of EMBARK-MT's ML education concerns the regulatory and ethical landscape of medical technology and ML, giving a deeper understanding of legislative boundaries and ethical considerations that are pivotal in innovation. Through case studies of ethics, legislation, and policy regarding medical technology and ML innovation, MT@B ensures that our members are creating safe and ethical technology applications that respect patients, privacy, bioethics, and user accessibility.

2.4 NMEP: InnovationRx PATHWAY

As a parallel course to EMBARK-MT, NMEP provides a biologically enriched educational pathway that has recently shifted to InnovationRx. To promote interdisciplinary ideation across clinically rich components of biomedicine and technology, NMEP partners with course staff from InnovationRx, an official student-run course at UC Berkeley. InnovationRx is a Democratic Education at Cal (DeCal) course exploring unmet clinical needs as areas of future innovation for students. Additionally, the course employs a seminar-style pedagogical technique with assignments graded on a pass or not pass (P/NP) basis, encouraging students to prioritize learning and intellectual growth.

InnovationRx begins each class with an introductory-level explanation of the lecture topic to make medical science accessible to students of various academic backgrounds. Each weekly lecture characterizes one anatomical system in both healthy and disease contexts, emphasizing current treatments and their shortcomings. Medical science lectures are paired with presentations about related medical technology to facilitate collaborative brainstorming about potential new avenues for medical technology innovation to treat the disease in question. Discussion groups for collaborative medical technology ideation are formed to encourage intellectual cross-over across different academic backgrounds and skill domains.

Over 12 weeks, the course progresses from an overview of approaches to solve unmet clinical needs to medical science seminars on oncology, nephrology, diabetes, and pulmonology with an emphasis on biology and physics concepts involved in pulmonary regulation, neurology, and urology (Table 2). Specific emphasis is given to oncological science and treatments for cancer, kidney disease, end-stage renal disease (ESRD), and common lung ailments as well as student-led medical device prototyping as a final project. Additional attention is given to socioeconomic barriers that exist in medicine and as predispositions to certain ailments. Paper reading skills are cultivated with weekly assignments to analyze assigned articles from medical research journals such as *Neurology* and *Journal of Nephrology*. These written assignments serve as standing measures of progress for students to examine the development of their approach to medical technology innovation.

2.5 MT@B Organization-Wide Educational Culture:

In addition, MT@B's organization-wide programs promote knowledge transfer and intellectual alignment across a multitude of skill sets which are fundamentally necessary for professional work in medical technology. Across the organization, MT@B congregates in full for two-hour General Meetings (GMs) once each week. GMs provide a platform for intellectual dialogue across the multitude of disciplines and MT@B operations represented in the organization's community. While internal updates provide members with knowledge of operations and projects within all sectors, external-facing operations allow members access to industry-grade knowledge and first-hand insights from leading pioneers in the field of medical technology.

At GMs, MT@B promotes peer-to-peer instruction to build leadership skills in members when experienced members teach skill-building workshops on Website Development, Surgical Knot Tying, Brain Scan Analysis and Terminology, and Medical Technology in History. Many of these meetings encourage ad-hoc presentations on prominent companies in the medical technology industry and cultivate socratic seminar-style discussion skills in scientific areas on novel research developments such as AlphaFold2[3], implications of telemedicine technology on patient privacy, and cybersecurity in medical technology.

3 RESULTS

By fostering a tight-knit community for the administration of peer-to-peer educational curricula, MT@B's NMEP provides hands-on technical education opportunities through technologically and biologically enriched pathways supplemental to undergraduate coursework.

3.1 Results of NMEP Program Components

3.1.1 NMEP: Pedagogical Insights and Results

For students across a variety of disciplines, NMEP decreased the barrier to entry into the field of medical technology. Delving into important and cutting-edge topics such as CV and ML in EMBARK-MT provided students with the skills needed to succeed in MT@B Incubator projects and to obtain work experiences in the applied technology industry. EMBARK-MT's concise lectures paired the most important technical knowledge and material with hands-on activities for students to apply and understand the topics they just learned. Giving new members an opportunity to learn these extensive topics over 12 weeks not only gave them the ability and opportunity to participate in club-wide projects next semester but also fostered their growth in these fields for their future in industry or academia.

3.1.2 EMBARK-MT: Pedagogical Insights and Results

EMBARK-MT members successfully gained exposure across five areas: medical technology industry landscape, basics of biology and medical specialties, computer science and software engineering fundamentals, foundational skills for medical informatics including data analytics and ML, and medical engineering including the anatomy of medical circuit boards and important devices in the field. Members acquired introductory skill sets that enabled efficient pathways to success in projects in MT@B. EMBARK-MT also increased students' proficiency in research at UC Berkeley. As a result of this concise delivery of hands-on education through a semester-long education program, EMBARK-MT effectively shortened the time required to acquire relevant skills as compared to several year-long degree programs in computer science and biomedical engineering.

3.1.3 InnovationRx: Pedagogical Insights and Results

InnovationRx employs a medical research-focused lens to medical technology, encouraging students to use medical science to inform medical technology ideation, such as using nephrology knowledge to innovate treatments for ESRD. The class is successful in cultivating interdisciplinary thinking without prior domain knowledge. Additionally, the course brings in two guest speakers per semester to help teach the students about taking unique approaches to innovation, including Dr. Syed Hossainy a UC Berkeley Bioengineering Professor. At the end of the semester, students present a medical technology proposal to cultivate product development skills.

Table 1. EMBARK DeCal Syllabus.

Week	Topic	Description	Assignments
1	**Introduction to Medical Technology**	**Lecture:** - What is medical technology and its significance in healthcare - Introduction to the medical technology industry and key companies **Discussion/Lab:** - Overview of the syllabus and the structure of the course (Discussion) - GitHub basics for collaborative coding (Lab) - Understanding the role of GitHub in collaborative project development (Discussion)	**Vitamin:** - Reflecting on the importance of collaboration in medical technology projects
2	**Medical and Biological Basics**	**Lecture:** - Central dogma theory and its relevance to medical technology - Understanding human anatomy and major organ systems - Introduction to various types of medical data and their importance **Discussion:** - Exploring different medical specialties and their focuses - Basics of data analysis using Numpy, Pandas, and Matplotlib - Visualizing biological data to gain insights (Hands-on activity)	**Vitamin:** - Connecting biological concepts with the potential for data analysis
3	**Informatics Basics (Data Science Practice)**	**Lecture:** - Introduction to hypothesis testing and biostatistics - Introducing regression and its applications (Lecture) - Signal processing fundamentals for medical data (Lecture) **Discussion/Lab:** - Building on Numpy, Pandas, and Matplotlib skills - Discussing the role of data analysis in medical technology (Discussion) - Applying data analysis techniques to medical datasets (Hands-on activity)	**Vitamin:** - Leveraging regression techniques for medical data analysis (Vitamin)
4	**SWE Basics (Full-Stack Lecture)**	**Lecture:** - Understanding Brain Computer Interfaces - Good programming practices and modular code development - Introduction to databases and their role in medical technology - Server-side programming and APIs for medical applications **Discussion/Lab:** - Building a basic medical device prototype using Arduino or Raspberry Pi (Lab) - Applying modular code development principles to medical device projects (Hands-on activity)	**Vitamin:** - Recognizing the importance of software engineering in medical technology
5	**ML Basicds (Supervised and Unsupervised Learning)**	**Lecture:** - Exploring supervised and unsupervised learning in med tech - Introduction to regression and classification algorithms - Exploring various classifiers and clustering algorithms **Discussion/Lab:** - Understanding the concepts of overfitting and generalization (Discussion) - Hands-on activity on implementing decision trees (Lab) - Applying machine learning to medical data classification (Hands-on activity)	**Vitamin:** - Reflecting on the power of machine learning in healthcare
6	**Medical Devices and Data Modalities**	**Lecture:** - Introduction to medical devices and their classifications - Anatomy of medical circuit boards and their functions **Discussion/Lab:** - Understanding biosensors and data modalities in medical technology - Building a basic EEG using Brain Computer Interfaces - Exploring the role of medical devices in capturing and processing data (Hands-on activity)	**Vitamin:** - Recognizing the potential of medical devices to improve patient outcomes
7	**Computer Vision and Medical Imaging**	**Lecture:** - Introduction to CV and its applications in med tech - Understanding convolutional neural networks (CNNs) - Data augmentation and pre-processing for image analysis **Discussion/Lab:** - Exploring different scanning and imaging technologies (Discussion) - Practical session on using CV packages and pipelines (Lab) - Applying CNNs to medical image analysis (Hands-on activity)	**Vitamin:** - Realizing the impact of computer vision on medical diagnostics
8	**Language Models and MedTech Applications**	**Lecture:** - Exploring the application of language models in MedTech, including chatbots **Discussion/Lab:** - Group discussion on recent advancements in language models (Discussion) - Team presentations on "Attention is All You Need" and its relevance (Activity) - Understanding how language models are transforming medical data analysis (Discussion)	**Vitamin:** - Connecting the potential of language models with MedTech innovation
9	**Project Work Session**	Project Work Session	Presentations Next Week!
10	**MedTech Applications**	Project Presentations	**Vitamin:** - Acknowledging the growth and potential of each participant

3.2 General Meetings: Cultivating Intellectual Skill through Speaker Events

At GMs, MT@B hosts professionals in the medical technology industry to present on professional development, medical technology research, startup ecosystem insights, and the state of the medical technology industry. To foster industry-grade discussions about medical technology research, MT@B hosted Dr. Adheel Akhtar, the founder and CEO of PSYIONIC, where he has pioneered the world's first bionic prosthetic. In addition to offering invaluable insights on the restless reinvention that was required to build the world's first bionic hand and the iterative readjustment of his corporate vision that led to the establishment of PSYIONIC as a company, Dr. Akhtar selected a student to demonstrate the functionality enabled by the bionic hand. Through direct interaction with Dr. Akhtar's Bluetooth-controlled bionic hand, MT@B members attained a tangible representation of what their education might empower them to build and how those innovations can change the technological ecosystem involved in medical care for amputees.

Figure 1. Decision Tree Hyperparameter Tuning Lab.

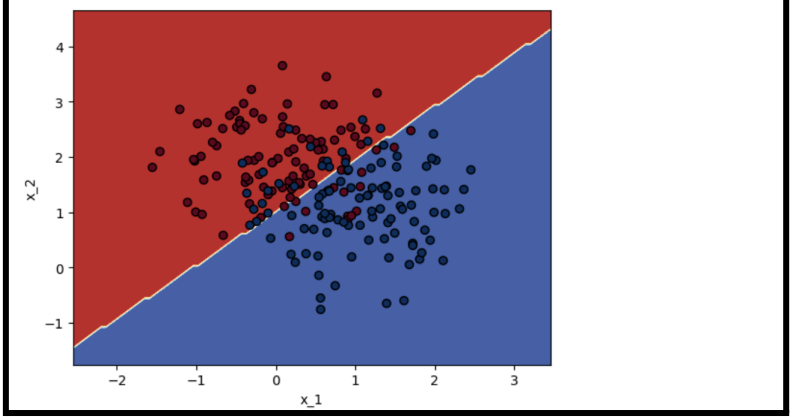
To visualize the results, we're going to make a heatmap showing how the model will classify every possible point

```
from sklearn.inspection import DecisionBoundaryDisplay

def make_heatmap(classifier, X, y):
  DecisionBoundaryDisplay.from_estimator(
      clf,
      X,
      cmap=plt.cm.RdYlBu,
      response_method="predict",
      xlabel='x_1',
      ylabel='x_2',
  )

  plt.scatter(X[:, 0], X[:, 1], c=y, edgecolors='k', cmap='RdBu')

make_heatmap(clf, X, y)
```



At MT@B, GM Speakers who share insights into novel research and technology development are met with an academically diverse audience that asks in-depth questions across biomedical sciences, computer science, hardware engineering, and business operations. Such speakers serve as a direct source of scientific enlightenment to foster research discussions across topics such as neural engineering, neural signal decomposition, mathematical signal processing techniques, CV, and mechanical prosthetic engineering. In this manner, GM speakers provide additional educational value to offer heavily enriched intellectual opportunities for students that exceed the classical textbooks, several hundred-person lecture halls, and test-based measures of comprehension of traditional undergraduate classroom settings.

To a similar effect, GM speakers also include industry professionals who share practical insights to facilitate the transition from undergraduate education to industry work in medical technology. One such speaker was Valentyna Akulova, a UX designer at a digital healthcare startup with previous experiences as a software developer and lab research assistant at a molecular diagnostics laboratory. An additional example of speakers who provide invaluable insight on transferring skills from undergraduate education directly to the workforce is Luka Lamaj, Co-Founder and CEO of Docere Health and Co-Director of Nucleate Dojo. Lamaj spoke about the rise of his Canadian AI telemedicine startup which aims to alleviate physician burnout through AI automation of patient intake forms. Lamaj's talk cultivated a discussion about Canada's free healthcare system and the United State's mixture of private, public, non-profit, and for-profit insurers and healthcare providers without universal healthcare[13][14]. With direct insights into the landscape of the medical technology industry across Canada and the United States, Lamaj enabled students to see beyond their country's borders and analyze the differences in healthcare systems and healthcare technology regulation between Canada and the United States.

GM Speakers provide direct value by increasing NMEP members' exposure to industry-grade work which traditional curricula fail to prioritize. Guest speakers provide additional educational value in the interdisciplinary research discussions they foster across MT@B's multidisciplinary organization. By prioritizing research discussions in a peer-led socratic seminar environment, MT@B promotes the development of scientific communication skills across both biomedical science and technology. Following Dr. Akhtar's talk, biomedical science students from Med R&D shared insights about the most common presentation of nerve viability in amputees they had completed clinical work with to inform discussions with Incubator members in UC Berkeley's Electrical Engineering and Computer Science degree program in discussions about neural signal decomposition in alternate forms of bionic

limbs as opposed to the demonstrated bionic hand prosthetic. MT@B resultantly makes strides towards the goal of producing medical technology professionals who are well-trained to communicate across both aisles of biomedical science and technology, as well as within their own disciplines.

Table 2. InnovationRx DeCal Syllabus.

Course Schedule

Week	Topic	Assigned Reading	Assignments
1	Introduction / Course Overview	https://www.healthaffairs.org/doi/full/10.1377/hlthaff.2023.00047	Journal Entry #1
2	Oncology	Any paper from the *Journal of Clinical Oncology*	Journal Entry #2
3	Nephrology	Any paper from the *Journal of Nephrology*	Journal Entry #3
4	Diabetes/ESRD	Any paper from *Diabetes*	Journal Entry #4
5	Guest Speaker	https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-018-5123-4	Journal Entry #5
6	Group Presentations	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6153631/	Presentation 1
7	Pulmonology	Any paper from *Pulmonology*	Journal Entry #6
8	Neurology	Any paper from *Neurology*	Journal Entry #7
9	Urology	Any paper from the *Journal of Urology*	Journal Entry #8
10	Guest Speaker	https://www.healthaffairs.org/doi/epdf/10.1377/hlthaff.2022.00119	Journal Entry #9
11	Final Presentations	https://www.healthaffairs.org/content/forefront/ensuring-access-generic-medications-us	Journal Entry #10
12	Final Presentations (cont.)	https://www.healthaffairs.org/content/forefront/innovation-bullying-drug-policy	Final Paper

4 CONCLUSIONS

On the whole, MT@B successfully addresses challenges in undergraduate training at the intersection of medicine and technology. NMEP, particularly the EMBARK-MT pathway, bridges the gap between traditional curricula and industry, providing hands-on experiences and exposure to cutting-edge technologies. Future directions include resource consolidation into a potential textbook publication to further enhance MT@B's impact on medical technology education. Through the use of undergraduate-led cohort-based training programs, MT@B prepares students for meaningful contributions in the evolving field of applied technology in medicine.

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