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NRT: Bootstrapping Graduate Students for Neuroengineering Research Through an Interactive Workshop

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NRT: Bootstrapping Graduate Students for Neuroengineering Research Through an Interactive Workshop

Introduction

Neuroengineering, or neural engineering, is an exciting discipline that applies engineering principles at the interface between living neural systems and non-living components [1]. Neuroengineering innovation requires convergence within a cross-disciplinary team that features engineers, neuroscientists, biologists, chemists, therapists, and physicians [2]. Despite the rapid progress of development in the field of neuroengineering, postgraduate training in neuroengineering rarely exists and often relies on a combination of neuroengineering practice and previous education in a sub-discipline [2, 3]. The lack of structured neuroengineering training poses a significant challenge in neuroengineering team's ability to understand and communicate cross-disciplinary ideas, an ability that is essential for organizational success [4].

University of California, Davis was awarded an NSF Research Traineeship (NRT) to cultivate the next generation of neuroengineers in 2022 [5]. Our first step to addressing the challenge is to deliver an interactive workshop in neuroengineering as the participants' first postgraduate training activity. The goal of the workshop design team is to train students to process neuroengineering data in a neuroscience context and form a community of neuroengineering practice to recruit for our NRT. We delivered an abbreviated 3-day workshop in 2022 during the week before instruction officially starts for the 2022-23 academic year. Since then, we have annually delivered an expanded 5-day workshop during the same period of the year.

Workshop Content

The current 5-day workshop accepts students by application only with annual participants around 20-25 students. Table 1 shows the agenda for our 2025 workshop.

Table 1. Full agenda of the 2025 Neuroengineering Workshop with color coded types of activities. Purple: mini projects. Yellow: panels. Blue: technical discussions. Orange: career skill-oriented sessions. Gray: ethics sessions. Green: research presentations.

Time	Monday	Tuesday	Wednesday	Thursday	Friday
9:00 AM	Breakfast and Registration Check				
9:15 – 9:30	Opening Remarks by Program PI				
9:30 – 10:15	Introduction to Neuroengineering	Campus Resources and Writing Center	Leadership	Managing Grad School	Campus Prototyping and Manufacturing Centers
10:15 – 11:00	Details of our NRT	Neuroengineering Industry Leaders Panel	NRT Leadership Faculty Panel	Neuroengineering Ethics	Fellowship Options and Getting Assistance
11:00 – 11:45	Grad Resource Fair organized by campus	Effects of preprocessing on outcomes	Managing Big Data	Ethics Case Studies	Writing Good Research Code
11:45 – 12:30	Lunch	Lunch	Lunch	Lunch	Lunch
12:30 – 3:00 Mini Projects	Introduction to Python	Investigating Neural Data in Python	Working with Time Series	Machine Learning Tools (Online Challenge Starts)	Machine Learning Tools (Finish Online Challenge)
3:00 – 4:00	Neuroengineering Faculty Panel	Research presentations from recruiting faculty	Research presentations from recruiting faculty	Identifying Relevant Neural Features	Senior Grad Students Panel
4:00 – 5:00	Reception	Social Activity	Social Activity	Social Activity	Awards Ceremony

The curriculum was developed using Kern's six-step model for curriculum development [6], a framework selected for its emphasis on targeted needs assessment and iterative evaluation. The team-based mini projects on Python and machine learning as well as the daily technical discussions, aim to prepare students of all skill levels in data science to process realistic neuroengineering data. Since our audience is new graduate students on campus, we introduced career skill-oriented sessions suitable for new graduate students and ample networking opportunities for the participants to meet like-minded peers, faculty, and professionals. At the end of each day, students are encouraged to participate in a networking event organized by the NRT committee or senior graduate students. The workshop packs 29 hours of training, connecting students to 16 neuroengineering faculty, ~10 senior graduate students, two campus staff members, and three neuroengineering industrial professionals.

Program Evaluation

The NRT team hired an external evaluator for program evaluation. After the workshop each year, the external evaluator sent the participating students a primarily quantitative post-survey that investigates students' satisfaction levels on the workshop components and potential impacts on participating in our NRT. The program evaluation received a Non-Human Subject Research (NHSR) designation from our IRB office (IRB #1877456-2). Participants were not compensated for filling out the survey.

Our program evaluators have provided us with results for the first four (2022-25) workshops. Participants' satisfaction levels on the program components are shown in Table 2. Aside from the 2023 ethics sessions, which were the only virtual sessions delivered over the lifetime of this workshop, every component has achieved a satisfaction rating of at least 4.13/5. Most other sessions received consistently high ratings over the three iterations of the workshop.

Table 2. Quantitative evaluation results of the 2022-25 workshop components (1 = very dissatisfied; 5 = very satisfied). The 2022 3-day workshop lacks the daily technical sessions and ethics sessions. The mini projects were offered in three sessions covering the current sessions 1-2, 3, 4-5 respectively. Sample number N varies since participants may not have attended all sessions.

	2022		2023		2024		2025	
Workshop Component	N	Score / 5	N	Score / 5	N	Score / 5	N	Score / 5
Social Activities	13	4.69	12	4.67	18	4.56	14	4.64
Managing Grad School	11	4.64	14	4.50	18	4.44	13	4.69
Networking Activities Session	12	4.58	16	4.75	19	4.63	15	4.87
Campus Facilities Session	12	4.50	15	4.67	17	4.65	12	4.50
Leadership Session	11	4.45	15	4.13	20	4.30	16	4.63
Fellowships Session	11	4.45	14	4.50	17	4.71	13	4.62
Daily Technical Discussions	-	-	16	4.63	19	4.68	14	4.71
Ethics Sessions	-	-	14	3.93	19	4.47	12	4.67
Mini Project 1: Introduction to Python	12	4.17	16	4.63	20	4.35	15	4.60
Mini Project 2: Neural Data			17	4.65	20	4.50	15	4.53
Mini Project 3: Working with Time Series	12	4.33	17	4.65	20	4.40	12	4.50
Mini Project 4: Machine Learning Tools (1)	13	4.23	15	4.87	19	4.37	16	4.44
Mini Project 5: Machine Learning Tools (2)			16	4.81	19	4.26	15	4.40

Table 3 shows that the workshop successfully connected the participants to our NRT program, by increasing their interest in participating in subsequent NRT-sponsored activities (open to all) and establishing a base level of expectation to fully complete our NRT.

Table 3. Quantitative evaluation results on students' association with the NRT which hosted this workshop (1 = strongly disagree; 5 = strongly agree). "-" means that the question was not asked in the post-survey of that year.

Statement	2022 (N=14) Score / 5	2023 (N=17) Score / 5	2024 (N=20) Score / 5	2025 (N=16) Score / 5
I better understand the components of the NRT.	4.71	4.71	4.85	4.69
I better understand the expectations the NRT has for me.	4.64	4.65	4.60	4.31
I know where to access information about the NRT.	4.50	4.65	4.75	4.81
I better understand campus facilities and resources.	4.36	4.65	4.75	4.75
I am better prepared to succeed in the NRT.	-	4.53	4.45	4.38
I am more likely to participate in other NRT activities.	-	-	4.55	4.53

Among the 52 participants who have provided qualitative feedback over four years, students considered the networking (29/52) and mini projects (24/52) to be the most valuable aspects of the workshop. Several (9/52) students in the research-track M.S. and Ph.D. degree programs considered the faculty research presentations to be the most valuable. Overall, students enjoyed working in teams for the mini project as well as the final online competition, while citing the positive connections made with like-minded peers and faculty. These encouraging results have affirmed that we have indeed built a valuable and interactive workshop to prepare incoming graduate students to pursue neuroengineering research at our institution.

Reflection

The NRT committee, over the past four years, have built a successful interactive workshop that prepares the students for graduate study in neuroengineering. The workshop has attracted more than 100 graduate student attendees from six graduate programs on campus, including biomedical engineering, computer science, electrical and computer engineering, mechanical and aerospace engineering, neuroscience, and psychology, in addition to a small number of undergraduate and postdoc participants.

The most significant change we have made to the format of the workshop is to extend the 3-day workshop to 5 days. After reviewing the qualitative feedback in 2022, we received conflicting feedback from the mini project being both too easy and too difficult. Attributing the polarized feedback in 2022 to the bi-modal skill distribution of the cohort, the NRT committee expanded the technical curriculum, starting with the mini projects from 4.5 hours total to 12.5 hours total in 2023. The redesigned mini projects offer a more gradual learning curve, offering lessened cognitive load [7] for participants without a data science background. The expanded time periods also allowed us to provide more neuroscience context for engineering students and cover materials in a more in-depth way for participants with stronger data science background. Daily technical discussions that complement the projects were also added to provide further insights into the integration of engineering and neuroscience in a neuroengineering context. Based on student feedback, we also added an in-depth ethics discussion in 2023, campus resource sessions

in 2024, a neuroengineering industry panel in 2025, and a technical discussion on collaborative coding in 2025, while iteratively refining other sessions, including moving the ethics sessions to in person for better student engagement.

The NRT committee was adamant on designing for more opportunities to connect students to faculty on campus, and this aspect was well received by participants. Although the mini project was primarily handled by a single facilitator, all technical discussions were led by different neuroengineering faculty on campus, and students are introduced to more opportunities to connect with faculty in the panels, faculty research presentations, and social events. In the qualitative feedback, students mentioned being able to connect with presenting faculty and secure rotation opportunities for their degree program. The deliberate inclusion of faculty participation and enthusiasm of faculty participation in our NRT contributed substantially to the success of our workshop.

Longitudinal tracking since we started tracking attendance in 2023 revealed that 22/40 students who attended at least two days of the workshop went on to attend at least 10 additional events, such as seminars organized by the NRT, demonstrating the value of the workshop as a recruitment tool as our NRT. Although, we have seen students, with M.S. students more than Ph.D. students, leaving after the first day. We hypothesize that these students may have discovered that neuroengineering may not be a good fit for their academic plan, or that they may no longer be interested in the program since they could not get their educational expenses covered by the NRT.

The NRT leadership considers the workshop to be a significant and valuable aspect of the NRT program and neuroengineering education on campus.

Acknowledgments

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References

[1] J. R. Hetling, "Comment on 'What is Neural Engineering?'," *Journal of Neural Engineering,* vol. 5, no. 3, pp. 360-361, 2008, doi: 10.1088/1741-2560/5/3/n01.

[2] E. S. Ereifej *et al.*, "Neural engineering: the process, applications, and its role in the future of medicine," *Journal of Neural Engineering,* vol. 16, no. 6, 2019, doi: 10.1088/1741-2552/ab4869.

[3] R. Ghannam, G. Curia, G. Brante, S. Khosravi, and H. Fan, "Implantable and Wearable Neuroengineering Education: A Review of Postgraduate Programmes," *IEEE Access,* vol. 8, pp. 212396-212408, 2020, doi: 10.1109/access.2020.3040064.

[4] W. P. Boon, M. M. Chappin, and J. Perenboom, "Balancing divergence and convergence in transdisciplinary research teams," *Environmental science & policy,* vol. 40, pp. 57-68, 2014.

[5] X. Wang *et al.*, "NeuralStorm: Training Graduate Students to Take Neuroengineering by Storm," in *2025 ASEE PSW Conference*, 2025, doi: 10.18260/1-2--55184.

[6] D. E. Kern, "A six-step approach to curriculum development," in *Curriculum development for medical Education a six-step approach*: The Johns Hopkins University Press Baltimore, 2009, pp. 5-9.
[7] J. Sweller, "Cognitive load theory," in *Psychology of learning and motivation*, vol. 55: Elsevier, 2011, pp. 37-76.