Application Cover Letter

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April 12, 2012

ATTN: *Faculty Search Committee*

Department of Neuroscience
Brown University
Providence, RI

Dear Members of the Search Committee,

I am writing to apply for the computational neuroscience faculty position advertised on your department website. I received my PhD degree in Electrical Engineering and Computer Science (EECS) from MIT in June 2011. My PhD dissertation was focused on interdisciplinary work at the interface of neuroscience and electrical engineering in collaboration with the MIT EECS and Brain and Cognitive Sciences (BCS) Departments, and the Center for Nervous System Repair at Harvard Medical School. Since then, I have been a postdoctoral fellow with joint appointments at Harvard Medical School, Massachusetts General Hospital, and MIT EECS. The enclosed application summarizes my interdisciplinary academic preparation, teaching, and research experiences.

As described in my application, I am interested in using the principles of information and control theories and statistical signal processing to gain insight into basic neuroscience questions and in turn combine such insights and principles to develop novel solutions for clinical neuroscience problems. In my PhD work, I focused on the design of novel brain-machine interface (BMI) architectures that map (decode) the brain signal into intended movements with the aim of enabling motor function in disabled patients. I developed both a BMI architecture to restore natural motor function and the first concurrent BMI architecture with the exciting potential to surpass such natural motor function. I implemented these BMI architectures in rhesus monkeys. In addition to the BMI development, another closely related clinical neuroscience problem of interest to me is the control of the brain state under general anesthesia by developing novel stochastic controllers for anesthesia drug delivery. In the enclosed research statement, you can find a summary of my current research projects and my future research directions.

During my graduate studies at MIT, I served as a teaching assistant (TA) and taught recitation sessions in both undergraduate and graduate courses. In particular, I served as a TA for a newly developed graduate course "Inference and Information", which teaches the principles of Bayesian and non-Bayesian statistical inference. Besides teaching classical courses on statistical inference, signal processing, and estimation theory, my interdisciplinary research interests and my teaching experience uniquely position me to develop new graduate courses on these topics with application to neuroscience and neural engineering. I believe that such courses will be of interest to neuroscience, biomedical, electrical, and computer engineering students. Further details about my teaching activities and interests may be found in the attached teaching statement.

I have also included the names and contact information of five references in my CV. I am looking forward to having the opportunity to discuss my interests and qualifications pertaining to the advertised position with you.

Thank you for your time and consideration.

Sincerely,
Maryam M. Shanechi

Maryam M. Shanechi

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EDUCATION

Ph.D., *Massachusetts Institute of Technology*, Elect. Eng. & Comp. Sci. 06/2011

<u>*Dissertation*</u>: Real-Time Brain-Machine Interface Architectures: Neural Decoding from Plan to Movement

Advisors: Emery N. Brown and Gregory W. Wornell

GPA: 5/5 (Natural Sciences and Engineering Research Council of Canada Fellow)

Dissertation Summary: This was an interdisciplinary work in collaboration with the MIT Electrical Engineering and Brain and Cognitive Sciences Departments, and the Center for Nervous System Repair at Harvard Medical School. This work designs novel brain-machine interface (BMI) architectures for mapping (decoding) the brain signal into intended movements and implements these BMI architectures in rhesus monkeys. It develops both a BMI architecture to restore natural motor function in disabled patients and a BMI architecture with the exciting potential to surpass such natural motor function.

S.M., *Massachusetts Institute of Technology*, Elect. Eng. & Comp. Sci. 06/2006

<u>*Thesis*</u>: Universal Codes for Parallel Gaussian Channels

Advisors: Gregory W. Wornell and Uri Erez

GPA: 5/5

Thesis Summary: This work develops efficient universal and rateless coding architectures for communication over parallel and multiple-input multiple-output (MIMO) Gaussian channels.

B.A.Sc., *University of Toronto*, Engineering Science, with honors 06/2004

<u>*Thesis*</u>: On the Importance of Phase in Speech Recognition

GPA: 3.96/4 (ranked first in the Faculty of Engineering)

Thesis Summary: This work investigates the effects of uncertainty in the phase of speech signals on the word recognition error rate of human listeners.

RESEARCH EXPERIENCE

Postdoctoral Fellow, Neuroscience Statistics Research Lab 07/2011–present
Harvard Medical School, Massachusetts General Hospital, and MIT

Graduate Research Assistant, Signals, Information, and Algorithms Lab 09/2004–06/2011
Massachusetts Institute of Technology

Graduate Research Assistant, Neuroscience Statistics Research Lab 09/2008–06/2011
Massachusetts Institute of Technology

Graduate Research Assistant, Ziv Williams Lab 09/2008–06/2011
Center for Nervous System Repair, Harvard Medical School

Undergraduate Research Assistant, Artificial Perception Lab 06/2002–06/2004
University of Toronto

TEACHING EXPERIENCE

Teaching Assistant, 6.437: Inference and Information (graduate level) 01/2009–06/2009
Massachusetts Institute of Technology
Subject includes Bayesian and non-Bayesian statistical inference and information theory.

Teaching Assistant, 6.437: Inference and Information (graduate level) 01/2007–06/2007
Massachusetts Institute of Technology

Teaching Assistant, 6.011: Communication, Control, and Signal Processing (senior level), Massachusetts Institute of Technology 01/2005–06/2005

Teaching Assistant, Calculus (undergraduate level) 09/2003–12/2003
University of Toronto

INDUSTRY EXPERIENCE

Summer Intern, NextWave Wireless, San Diego, CA 06/2008–09/2008

Designed a novel practical hybrid feedback algorithm for multiuser MIMO systems using a joint source-channel coding approach. This work resulted in a conference paper, a journal paper, and a patent.

Research Intern, HP Labs, Palo Alto, CA 01/2008–02/2008

Developed an offline echo cancellation algorithm with application to teleconferencing.

Summer Intern, NextWave Wireless, San Diego, CA 06/2007–09/2007

Investigated the performance of different codebook based feedback algorithms for closed-loop MIMO applications.

Summer Intern, Vanu Inc., Cambridge, MA 06/2006–09/2006

Explored parts of a downlink CDMA-2000 communication receiver including the channel estimator and channel equalizer and compared the performance of different equalizers.

Summer Intern, Vanu Inc., Cambridge, MA 06/2005–09/2005

Developed power control algorithms for GSM communication systems.

Summer Intern, Altera Corp., Toronto, ON 06/2004–09/2004

Modeled dynamic and static Input/Output (I/O) power consumption in Altera FPGAs.

AWARDS AND RECOGNITIONS

Doctoral Fellowship 2006–2009
Natural Sciences and Engineering Research Council of Canada (NSERC)

Hewlett-Packard Graduate Fellowship 2006

Gold Medalist, Professional Engineers of Ontario (PEO) 2004
Ranked first among all graduates in the Faculty of Engineering at the University of Toronto

Wilson Medal in Engineering Science 2004
Ranked first among all Engineering Science graduates at the University of Toronto

Canada Post Graduate Scholarship Winner 2004

Exceptional Student 2004
Selected by the Skulematters Magazine published by the Faculty of Engineering, University of Toronto

Next Generation of Canadian Leaders 2004
Selected by the University of Toronto Magazine

NSERC Undergraduate Research Fellowship 2003

NSERC Undergraduate Research Fellowship 2002

PUBLICATIONS

Books

1. Aarabi P., Shi G., **Shanechi M. M.**, Rabi S.: "Phase-based speech processing", World Scientific, 2005.

Peer-Reviewed Journal Papers

8. **Shanechi M. M.**, Hu R., Powers M., Wornell G. W., Brown E. N., Williams Z. M.: "A concurrent brain-machine interface for enhanced motor function", *Nature Neuroscience (revised Jan. 2012)*.
7. **Shanechi M. M.**, Wornell G. W., Williams Z. M., Brown E. N.: "Feedback-controlled parallel point process filter for estimation of goal-directed movements from neural signals", *IEEE Transactions on Neural Systems and Rehabilitation Engineering (under revision)*.
6. **Shanechi M. M.**, Williams Z. M., Wornell G. W., Hu R., Powers M., Brown E. N.: "A real-time brain-machine interface combining motor target and trajectory intent using an optimal feedback-control design", *PLoS ONE (revised Feb. 2012)*.
5. Williams Z. M., **Shanechi M. M.**, Hu R.: "Re-approximating the function of disrupted CNS pathways", *under review*.
4. **Shanechi M. M.**, Erez U., Wornell G. W.: "Universal codes for parallel Gaussian channels", *in preparation*.
3. **Shanechi M. M.**, Porat R., Erez U.: "Comparison of practical feedback algorithms for multiuser MIMO", *IEEE Transactions on Communications*, 58 (8), Aug. 2010.
2. Shi G., **Shanechi M. M.**, Aarabi, P.: "On the importance of phase in human speech recognition", *IEEE Transactions on Audio, Speech and Language Processing*, 14 (5), Sep. 2006.
1. Mavandadi S., Aarabi P., Mohajer K., **Shanechi M. M.**: "Post recognition speech localization", *International Journal of Speech Technology*, 8 (2), Jun. 2005.

Peer-Reviewed Conference Papers

6. **Shanechi M. M.**, Wornell G. W., Williams Z. M., Brown E. N.: "A parallel point-process filter for estimation of goal-directed movements from neural signals", IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), 14–19 Mar. 2010, Dallas, TX.
5. **Shanechi M. M.**, Porat R., Erez U.: "Comparison of practical feedback algorithms for multiuser MIMO", IEEE Vehicular Technology Conference (VTC), 26–29 Apr. 2009, Barcelona, Spain.
4. **Shanechi M. M.**, Erez U., Wornell G. W.: "Rateless codes for MIMO channels", IEEE Global Communications Conference (GLOBECOM), 30 Nov. – 4 Dec. 2008, New Orleans, LA.

3. **Shanechi M. M.**, Erez U., Wornell G. W.: "Time-invariant rateless codes for MIMO channels", IEEE International Symposium on Information Theory (ISIT), 6–11 Jul. 2008, Toronto, ON.
2. **Shanechi M. M.**, Erez U., Wornell G. W.: "Universal coding for parallel Gaussian channels", IEEE International Zurich Seminar on Communications (ETH), 12–14 Mar. 2008, Zurich, Switzerland.
1. **Shanechi M. M.**, Aarabi P.: "Structural analysis of multisensor arrays for speech separation applications", Sensor Fusion: Architectures, Algorithms, and Applications VII, Apr. 2003, Orlando, FL.

Conference Presentations

5. **Shanechi M. M.**, Hu R., Powers M., Wornell G. W., Brown E. N., Williams Z. M. (reviewed abstract): "A concurrent brain-machine interface for enhanced motor function", Computational and Systems Neuroscience (COSYNE), 23–26 Feb. 2012, Salt Lake City, Utah.
4. **Shanechi M. M.**, Hu R., Powers M., Wornell G. W., Brown E. N., Williams Z. M. (non-reviewed abstract): "A real-time concurrent brain-machine interface for performing sequential movements", 41st Annual Meeting, Society for Neuroscience, 12–16 Nov. 2011, Washington, DC.
3. **Shanechi M. M.**, Williams Z. M., Wornell G. W., Brown E. N. (reviewed abstract): "A brain-machine interface combining target and trajectory information using optimal feedback control", COSYNE, 24–27 Feb. 2011, Salt Lake City, Utah.
2. **Shanechi M. M.**, Williams Z. M., Wornell G. W., Brown E. N. (non-reviewed abstract): "Combining plan and peri-movement activities improves the performance of brain-machine interfaces", 40th Annual Meeting, Society for Neuroscience, 13–17 Nov. 2010, San Diego.
1. **Shanechi M. M.**, Williams Z. M., Wornell G. W., Brown E. N. (reviewed abstract): "A real-time brain-machine interface combining plan and peri-movement activities", Research in Encoding And Decoding of Neural Ensembles Conference (AREADNE), 17–20 Jun. 2010, Santorini, Greece.

INVITED TALKS

8. Shanechi M. M.: "Real-time brain-machine interface architectures: neural decoding from plan to movement", School of Electrical and Computer Engineering, Cornell University, Apr. 19, 2012, Ithaca, NY.
7. Shanechi M. M.: "Real-time brain-machine interface architectures: neural decoding from plan to movement", Department of Electrical and Computer Engineering, Rice University, Mar. 14, 2012, Houston, TX.
6. Shanechi M. M.: "Real-time brain-machine interface architectures: neural decoding from plan to movement", Division of Biology, California Institute of Technology (Caltech), Jan. 9, 2012, Pasadena, CA.
5. Shanechi M. M.: "Real-time brain-machine interface architectures: neural decoding from plan to movement", Department of Electrical Engineering, University of Southern California (USC), Dec. 1, 2011, Los Angeles, CA.
4. Shanechi M. M.: "Real-time brain-machine interface architectures: neural decoding from plan to movement", Department of Biomedical Engineering, Johns Hopkins University, Nov. 28, 2011, Baltimore, MD.

3. Shanechi M. M.: "Real-time brain-machine interface architectures for enhanced motor function", IEEE Engineering in Medicine and Biology Society (EMBS), Sep. 1, 2011, Boston, MA.
2. Shanechi M. M.: "Real-time brain-machine interface architectures: neural decoding from plan to movement", Cold Spring Harbor Laboratory, Jun. 8, 2011, Cold Spring Harbor, NY.
1. Shanechi M. M.: "On universal coding for parallel Gaussian channels", Information theory and applications (ITA) lecture series, University of California San Diego (UCSD), Aug. 26, 2008, San Diego, CA.

PATENTS

1. Porat R., **Shanechi M. M.**, Erez U.: "Hybrid feedback for closed loop multiple-input multiple-output", World Intellectual Property Organization (WIPO) patent WO/2010/025426, issued Apr. 2010.

PROFESSIONAL AFFILIATIONS

Society for Neuroscience (SFN); Institute of Electrical and Electronics Engineers (IEEE);

REFERENCES

1. Emery N. Brown, M.D., Ph.D.
   Professor
   Department of Brain and Cognitive Sciences
   Harvard-MIT Division of Health Sciences and Technology
   Massachusetts Institute of Technology
   77 Massachusetts Avenue, 46-6079
   Cambridge, MA 02139
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2. Gregory W. Wornell, Ph.D.
   Professor
   Department of Electrical Engineering and Computer Science
   Massachusetts Institute of Technology
   77 Massachusetts Avenue, 36-677
   Cambridge, MA 02139
   Tel: (617) 253-3513
   Email: gww@mit.edu
3. Ziv M. Williams, M.D.
   Assistant Professor, Attending Neurosurgeon
   Department of Neurosurgery
   Harvard Medical School, Massachusetts General Hospital
   55 Fruit Street, WAC 745K
   Boston, MA 02114
   Tel: (617) 643-4687
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4. Polina Golland, Ph.D.
   Associate Professor

Department of Electrical Engineering and Computer Science
Massachusetts Institute of Technology
77 Massachusetts Avenue, 32-D470
Cambridge, MA 02139
Tel: (617) 253-8005
Email: polina@csail.mit.edu

5. Uri Erez, Ph.D.
   Senior Lecturer
   School of Electrical Engineering
   Tel Aviv University
   Ramat Aviv, Israel
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Maryam M. Shanechi
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Research Statement

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General Research Interests

I am interested in using the principles of information and control theories and statistical signal processing to gain insight into basic neuroscience questions and in turn combine such insights and principles to develop novel solutions for clinical neuroscience problems and potential non-clinical applications. In my research, the key for developing such effective solutions is an approach based on the fundamentals of systems theory and guided by an understanding of the related neural processes, as opposed to a black box modeling approach typically used. A challenging clinical neuroscience problem of interest to me, where such a principled approach could offer significant advantage, is the development of brain-machine interfaces (BMIs) to decode movement intentions from neural activity and enable motor function in disabled patients. Advancing BMI designs through a better understanding of the neural mechanisms that are responsible for planning and controlling movements is one of my key research goals. By understanding how the sensorimotor system controls movements, I intend to develop control-theoretic designs that emulate the processes underlying natural motor function. I am also interested in understanding how motor learning and adaptation happen in the brain, and can in turn be incorporated into the BMI design. In addition, I am pursuing the design of BMI architectures that aim to not only restore natural motor function, but also surpass it, for example allow a person to function faster, better, or safer than possible by natural movement. In addition to the BMI development, another closely related clinical neuroscience problem of interest to me is the control of the brain state under general anesthesia by developing a novel feedback-controlled anesthesia drug delivery system. Similar to BMIs, these systems work by observing the related brain activity to infer the brain's anesthetic state. This inference is used to control the real-time rate of drug administration in order to maintain a desired brain state and avoid undesired consequences such as drug overdose. Below, I provide a summary of my past and current research work and example future research directions.

Past and Current Research

In my PhD work, I focused on the development of real-time BMI architectures for decoding movement intentions from neural signals. BMIs aim to enable motor function in individuals with neurological injury or disease, by recording the neural activity (typically the spiking activity of neurons), mapping or decoding it into a motor command, and then controlling a device such as a robotic arm to execute the intended movement. Despite exciting proof of concept demonstrations, performance of BMIs needs to be significantly improved before they become clinically viable. BMIs are typically developed without much consideration given to the basic principles underlying natural motor control and to the true nature of the recorded spiking activity. First, since most movements are controlled and made to reach a target, the problem of BMI design is fundamentally a control theory problem. Second, the spiking activity is discrete and resembles a series of zeros and ones, modeled well as a point process. Since standard signal processing algorithms have been developed for continuous valued processes, most BMIs convert the spiking activity into a continuous valued signal. This conversion can result in information loss, compromising the accuracy of the decoded movement.

To resolve these issues, I developed a BMI that incorporates the basic control principles underlying natural motor function and also directly models the spiking activity as a point process. Inspired by the fact that the brain controls a movement to reach a target while receiving sensory (such as visual) feedback about the real-time state of the limb, I used optimal feedback control theory as a modeling approach. Specifically, I posed the BMI problem as that of estimating the states of an optimal feedback-controlled system from observations of neural point processes. Moreover, since information about the target location of a movement as well as its kinematics is encoded in the brain, I implemented, in monkeys, the first real-time BMI that estimated both jointly using the optimal feedback control approach. I demonstrated that the resulting BMI achieved more accurate estimation of movement than a design not including the feedback-controlled decoder. The results of this work have been revised for publication in PLoS ONE and are under revision for publication in IEEE Transactions on Neural Systems and Rehabilitation Engineering.

While the feedback-controlled BMI attempted to match natural motor function, I also pursued the compelling goal of designing a BMI that can surpass such function, for example allow a task to be performed faster, better, or safer than is otherwise possible by natural movement. Since typical motor activities—such as playing a succession of notes on a piano—consist of a sequence of planned movements, a BMI that can decode the whole planned sequence simultaneously and in advance of execution can analyze it to find ways to perform the task more effectively. I thus investigated the neural mechanisms involved in planning a sequence of movements before their initiation, i.e., during a working memory period. I discovered an intriguing functional structure in the premotor cortex of monkeys. My analysis showed that the neural population partitioned into subpopulations, each responsible for holding information about a single planned movement. This mechanism enabled the neural population to simultaneously and accurately hold information about all planned movements during working memory. Capitalizing on this new physiological finding, I developed the first BMI with the ability to concurrently decode a sequence of planned movements in advance of their initiation and then accurately execute them as desired, e.g., much faster than possible by natural movement. This is the first concurrent BMI with the exciting potential to surpass natural motor function. The findings of this work have been revised for publication in Nature Neuroscience.

Future Research Directions

My first research goal is to further advance the BMI designs by extending the above developments. One direction I intend to pursue is to understand and incorporate in the BMI designs the effect of learning and adaptation in the brain. It has been observed that the brain could adapt to a BMI decoder and learn to use it more accurately with practice. This has been combined with an observation of a dynamic change in the properties of the neural activity. Such observations have resulted in two major approaches in the community. One that argues that BMIs should primarily rely on learning to achieve high performance and one that puts the emphasis on optimizing the decoder design. I will incorporate these two approaches into a unified framework to optimize the BMI performance. On one front, I will develop an adaptive version of the feedback-controlled point-process decoder to estimate the intended movement while tracking the changes in the mapping between brain and behavior, which could be a result of learning. An interesting question that arises then is whether a changing decoder that attempts to track the brain dynamics hurts or helps the learning in the brain and the overall BMI performance. On the other front, I will investigate this question from a reinforcement learning perspective to understand the behavior of two dynamic systems (brain and decoder) that jointly learn each other to accomplish a common goal.

In my PhD work, I implemented and tested the feedback-controlled point process decoder in monkeys for controlling the position of a cursor on a computer screen. I plan to examine the extension of this decoder for controlling more dynamically demanding movements such as those produced by prosthetic limbs. Using models of the prosthetic limb (the plant), a quantitative definition of task performance, optimal feedback control theory, and point process modeling of the spiking activity, I plan to develop decoders that can control these movements while taking into account the sensory feedback and dynamics of the limb.

I also plan to investigate why the neural mechanisms involved in addition of information to working memory result in its capacity for information storage to be fundamentally limited. Behavioral studies in both human and non-human primates have demonstrated that most subjects can only accurately hold in working memory, on average, three to four items at any given time. Therefore it is interesting to examine why only a small number of items can be held in working memory in comparison with long-term memory. An interesting finding in my work on the design of BMIs for sequential movements was regarding the neural mechanisms involved in addition of information to working memory. In the related experiments, I found that when monkeys were required to sequentially add to working memory information about two target locations of a sequential movement, the added information about the later target was encoded by a smaller number of neurons than the number encoding the concurrently held information about the first target. It is, therefore, interesting to speculate whether the fact that a progressively smaller number of neurons were recruited for encoding of added information explains the limitation on the number of items of information that may be held during working memory. Future experiments that employ a larger number of targets may help answer why only a small number of items can be held in working memory in comparison to other forms of memory storage.

My second research goal is to solve the closely related problem of controlling the brain state under general anesthesia by developing a feedback-controlled anesthesia drug delivery system. Similar to BMIs, these systems work by observing the brain activity, in this case the electroencephalogram (EEG) pattern that is related to the effect of anesthetic drug, and then using it to infer the brain's anesthetic state. This inference is used to control the real-time rate of drug administration in order to maintain a desired brain state. As an indicator of this state, these systems define a control marker based on the EEG that must be estimated and kept at a target value. Using real-time calculations of the marker as a feedback signal, they guide the real-time drug administration to keep the marker at the pre-specified target value. So far these systems have not demonstrated robust anesthetic control for individual patients. This can be attributed to the limited understanding of the relationship between the EEG and the brain's anesthetic state and the need to determine a clear EEG marker with a unique map to this state. I intend to develop a control system for burst suppression, a well-defined brain state of general anesthesia. Burst suppression is a state of profound brain inactivation seen for example in medical coma. In burst suppression, the EEG pattern consists of periods of electrical bursts, alternating with periods of isoelectricity. Hence I will model the EEG pattern as a point process and use the rate of electrical bursts as the control marker. I will develop a joint estimation and stochastic control framework based on the point process observations of burst suppression to precisely control its rate across time and in turn avoid the undesired consequences of drug overdose that could otherwise occur. Developing the solution for this well-defined brain state will guide my investigation into the broader problems of closed-loop control in general anesthesia.

The above summarize my research goals in the near future. In general, I am interested in conducting research at the interface of neuroscience and engineering. I therefore intend to lead an interdisciplinary research in which principled designs guided by fundamentals of systems theory could be combined with insights learned from neuroscience and in turn tested in modern neurophysiologic experiments. My interdisciplinary training and research and my experience in establishing successful collaborations across theoretical and experimental labs have prepared me to build and direct an interdisciplinary research group at Brown University's Department of Neuroscience focused on developing novel computational and engineering solutions to address standing challenges in basic and clinical neuroscience.

Maryam M. Shanechi
Harvard Medical School, MIT EECS

Teaching Statement

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My passion for teaching is one of the main reasons that I intend to pursue an academic career. In addition to an opportunity for preparing students for their future professions, I view teaching as an opportunity for learning and refining my own understanding of a topic. Further, such refined understanding could lead to new research ideas and research progress.

My teaching experience started when I was a senior and served as a teaching assistant (TA) for freshman calculus at the University of Toronto. I knew then that I really enjoy teaching and learning in the process. This led me to serve as a TA for both undergraduate and graduate classes at MIT. Even though I had research assistantships and fellowships during my graduate studies, I always sought opportunities to gain teaching experience and prepare myself for a teaching career. As a result, I accepted TA positions in three semesters in which, amongst other responsibilities, I taught recitation sessions. My first TA appointment was with Prof. George Verghese on "Introduction to Communication, Control, and Signal Processing", which teaches the common core of methodology involved in these subjects. I then served as a TA, twice, for a newly developed graduate course "Inference and Information" by Prof. Gregory Wornell and Prof. Polina Golland. This course teaches principles of Bayesian and non-Bayesian statistical inference such as hypothesis testing and parameter estimation, sufficient statistics, expectation-maximization algorithm, entropy and model capacity, asymptotic analysis and large deviations theory, approximation techniques and Monte Carlo methods, among others. Since this was a new course that was being developed as it was taught, I was involved in the process of preparing and refining course material based on class discussions and feedback from students.

Based on my own learning and teaching experiences, I believe an effective teaching strategy is to: 1. motivate the main topic of the lecture by posing related research problems, 2. teach the fundamentals of the subject and the related mathematical derivations, 3. show how the learned principles can be applied to solve example problems, and 4. design course problem sets and projects that require integration of the learned concepts with analytical thinking. This is the strategy that I intend to follow in my teaching.

I believe that teaching and research are closely connected; with teaching comes a refined understanding of the topic that can in turn lead to new research directions. The new findings in research are then integrated into teaching syllabus to improve the teaching curriculum. Teaching the "Inference and Information" course was very influential in me selecting my PhD direction. I realized that I was very interested in statistical inference and estimation theory and hence pursuing a line of research in the field. Combined with my interest in neuroscience, this led me to follow an interdisciplinary research direction and to use the principles of statistical inference to solve basic and clinical neuroscience problems.

With my teaching and research experiences in the past few years, I believe that I am prepared to teach classical courses on statistical inference, estimation theory, and signal processing at both undergraduate and graduate levels. In addition, I plan to develop a new graduate course on statistical inference and signal processing and their application to neuroscience and neural engineering. This course will concentrate on core inference principles and show their application to neural signal processing, for example modeling the neural spiking activity as a point process, building models for biological and neural processes based on data, and inference and approximation methods for such data. I believe that such a course will be of interest to students in computational neuroscience, biomedical, electrical, and computer engineering.

The rigorous training I have received in the fundamentals of systems, statistical inference, and signal processing, coupled with the interdisciplinary nature of my research and my passion for teaching and learning provide a strong foundation for teaching classical and theoretical courses as well as developing interdisciplinary courses across computational neuroscience, biomedical, electrical, and computer engineering. I view teaching as a priority in my academic career and strive for excellence in developing my teaching profession.