Nariman Farsad

CONTACT	**Department of Electrical Engineering**	(650) 556-5724
	Stanford University	nfarsad@stanford.edu
	350 Serra Mall, Stanford, 94305, CA	narimanfarsad.com

RESEARCH INTERESTS

Developing novel data-driven techniques based on machine learning and statistics for design and analysis of communication networks; Design and implementation of molecular communication systems; Foundational research areas: communication theory and signal processing, machine learning and deep learning, bioengineering;

ACADEMIC BACKGROUND

Electrical Engineering
Postdoctoral Research Scholar
- Hosted by: Andrea Goldsmith

Ph.D., Computer Science
- Thesis: Molecular Communication: From Theory to Practice
- Advisor: Andrew Eckford

M.Sc., Computer Science
- Thesis: Low-Complexity Energy Optimization of Wireless Sensor Networks

HONORS & AWARDS

NSERC of Canada Postdoctoral Fellowship ($90,000)	2015–2017
Best Demo Award for "Molecular MIMO Communication Link" at IEEE-INFOCOM	2015
Finalist in the **Bell Labs Prize** competition	2014
Second Prize at IEEE ComSoc Student Competition	2014
Ontario Graduate Scholarship Award ($30,000)	2012–2014
Queen Elizabeth II Graduate Scholarship in Science & Technology Award ($15,000)	2011
York University Graduate Scholarship Award ($4,000)	2010
York University Graduate Scholarship Award ($4,000)	2007

RESEARCH EXPERIENCE

Stanford University, Stanford, *Postdoctoral Research Scholar* 09/2015–Present
- Designed a novel sequence detector for continuous data streams using neural networks
- Developed neural network detectors for communication systems
- Designed neural network encoders and decoders for joint source-channel coding of text data
- Derived the fundamental capacity limits of different molecular communication systems
- Designed the optimal receiver for different molecular communication systems
- Built a novel experimental platform for in-vessel molecular communication

Kinboshi Networks Inc., Toronto, *Founder* 04/2014–02/2017
- Designed and built an experimental molecular communication platform that is sold to academic research groups around the world.

NTT DOCOMO Inc., Japan, *Research Subcontractor* 03/2010–03/2013
- Designed and analyzed on-chip molecular communication systems

York University, Toronto, *Research Assistant* 01/2010–07/2015
- Developed communication theoretic models, and designed and implemented a tabletop experimental platform for molecular communications

York University, Toronto, *Research Assistant* 09/2007–12/2009
- Designed a low-complexity energy-optimization scheme for wireless sensor networks using fractional cooperation and correlated sources.

MEDIA COVERAGE

- The Economist
- Forbes
- Stanford News
- Chemistry World
- IEEE Spectrum

- The Wall Street Journal
- CTV News
- Gizmodo
- Discovery Channel
- PHYS.ORG

- Engadget
- Globe and Mail
- National Post
- Wired
- Science & Vie

SUPERVISORY
EXPERIENCE

Mr. Mohamed Ibrahim AlHajri   Since Fall 2017
Co-supervising a PhD student from MIT
Project Title: "Automatic Modulation Classification Using Machine Learning"

Mr. Vahid Jamali   Summer and Fall 2017
Co-supervising a visiting PhD student from University of Erlangen-Nuremberg, Germany
Project Title: "Design and Analysis of Reactive Molecular Communication Systems"

Mr. Bonhong Koo   Summer and Fall 2017
Co-supervising a visiting PhD student from Yonsei University, South Korea
Project Title: "In-Vessel Molecular MIMO"

Mr. Jonathan Griffin   Spring 2017
Co-supervised an undergraduate research course project
Project Title: "An Automated Web Assessable Experimental Platform for Molecular Communication"

Mr. David Pan   Summer 2016
Co-supervised summer undergrad research project
Project Title: "Machine Learning for Molecular Communication Channels"

Mr. Liam Hassen Neath   Spring 2016
Co-supervised an undergraduate research course project
Project Title: "Simulation of Chemical Reactions and Chemical Signal Propagation"

Miss Lida Jabbari   2014–2015
Co-supervised M.A.Sc. project
Project Title: "Optimal Detection Algorithms for a Tabletop Molecular Communication Setup"

Mr. LinChen Wang   2013–2014
Co-supervised M.A.Sc. project
Project Title: "Communication Through Chemical Tags in Robotics"

Miss Na-Rea Kim   Summer 2013
Visiting PhD Student from Yonsei University, South Korea
Project Title: "Modeling Molecular Communication Systems with Metal-Oxide Detectors"

Mr. Anthony Calce   2010–2011
Co-supervised M.A.Sc. project
Project Title: "Implementation of Fractional Cooperation in Wireless Sensor Networks"

JOURNAL
PUBLICATIONS

[J21] **N. Farsad**, and A. Goldsmith, "Neural Network Detection of Data Sequences in Communication Systems," *IEEE Transactions on Signal Processing*, under review, 2018.

[J20] **N. Farsad**, Y. Murin, W. Guo, C.-B. Chae, A. Eckford and A. Goldsmith, "Communication System Design and Analysis for Asynchronous Molecular Timing Channels," *IEEE Transactions on Molecular, Biological and Multi-Scale Communications*, under review, 2018.

[J19] Y. Murin, **N. Farsad**, M. Chowdhury, and A. Goldsmith, "Exploiting Diversity in Molecular Timing Channels via Order Statistics," *IEEE Transactions on Molecular, Biological and Multi-Scale Communications*, under review, 2018.

[J18] **N. Farsad**, Y. Murin, A. W. Eckford, and A. Goldsmith, "Capacity Limits of Diffusion-Based Molecular Timing Channels," *IEEE Transactions on Information Theory*, under review, 2018.

[J17] Y. Murin, **N. Farsad**, M. Chowdhury, and A. Goldsmith, "Optimal Detection for Diffusion-Based Molecular Timing Channels," *IEEE Transactions on Molecular, Biological and Multi-Scale Communications*, under review, 2018.

[J16] V. Jamali, A. Ahmadzadeh, **N. Farsad**, and R. Schober, 'Constant-Composition Codes for Maximum Likelihood Detection without CSI in Diffusive Molecular Communications," *IEEE Transactions on Communications*, accepted, 2018.

[J15] V. Jamali, **N. Farsad**, R. Schober, and A. Goldsmith, "Non-Coherent Detection for Diffusive Molecular Communications," *IEEE Transactions on Communications*, accepted, 2018.

[J14] W. Guo, Y. Deng, B. H. Yilmaz, **N. Farsad**, M. Elkashlan, C.-B. Chae, A. Eckford, and A. Nallanathan, "SMIET: Simultaneous Molecular Information and Energy Transfer," *IEEE Wireless Communications*, accepted, in Press, 2017.

[J13] Y. Murin, **N. Farsad**, M. Chowdhurya, and A. Goldsmith, "Time-Slotted Transmission over Molecular Timing Channels," *Elsevier Nano Communication Networks*, vol. 12, pp. 12–24, 2017.

[J12] **N. Farsad**, B. H. Yilmaz, A. W. Eckford, C.-B. Chae, and W. Guo, "A Comprehensive Survey of Recent Advancements in Molecular Communication," *IEEE Communications Surveys & Tutorials*, vol. 18, no. 3, pp. 1887–1919, 2016.

[J11] B. Koo, C. Lee, H. B. Yilmaz, **N. Farsad**, A. W. Eckford, and C.-B. Chae "Molecular MIMO: From Theory to Prototype," *IEEE Journal on Selected Areas in Communications*, vol. 34, no. 3, pp. 600–614, 2016.

[J10] W. Guo, T. Asyhari, **N. Farsad**, B. H. Yilmaz, A. W. Eckford, and C.-B. Chae, "Molecular Communications: Channel Model and Physical Layer Techniques," *IEEE Wireless Communications*, vol. 23, no. 4, pp. 120–127, 2016.

[J9] W. Guo, C. Mias, **N. Farsad**, and J.-L. Wu, "Molecular Versus Electromagnetic Wave Propagation Loss in Macro-Scale Environments," *IEEE Transactions on Molecular, Biological, and Multi-Scale Communications*, vol. 1, no. 1, pp. 18–25, 2015.

[J8] **N. Farsad**, A. W. Eckford, and S. Hiyama, "Design and Optimizing of On-Chip Kinesin Substrates for Molecular Communication," *IEEE Transactions on Nanotechnology*, vol. 14, no. 4, pp. 699–708, 2015.

[J7] **N. Farsad**, N.-R. Kim, A. W. Eckford, and C.-B. Chae, "Channel and Noise Models for Nonlinear Molecular Communication Systems," *IEEE Journal on Selected Areas in Communications*, vol. 32, no. 12, pp. 2392–2401, 2014.

[J6] **N. Farsad**, A. W. Eckford, and S. Hiyama, "A Markov Chain Channel Model for Active Transport Molecular Communication," *IEEE Transactions on Signal Processing*, vol. 62, no. 9, pp. 2424–2436, 2014.

[J5] S. Qiu, W. Guo, M. Leeson, S. Wang, **N. Farsad**, and A. W. Eckford, "Nanoparticle Communications: from Chemical Signals in Nature to Wireless Sensor Networks," *Nanotechnology Perceptions*, vol. 10, no. 1, pp. 1–13, 2014.

[J4] **N. Farsad**, W. Guo, and A. W. Eckford, "Tabletop Molecular Communication: Text Messages Through Chemical Signals," *PLOS ONE*, vol. 8, no. 12, 2013.

[J3] **N. Farsad**, A. W. Eckford, S. Hiyama, and Y. Moritani, "On-Chip Molecular Communication: Analysis and Design," *IEEE Transactions on NanoBioscience*, vol. 11, no. 3, pp. 304–314, 2012.

[J2] **N. Farsad**, and A. W. Eckford, "Resource Allocation via Linear Programming for Fractional Cooperation," *IEEE Transactions on Wireless Communications*, vol. 11, no. 5, pp. 1633–1637, 2012.

[J1] **N. Farsad**, A. W. Eckford, S. Hiyama, and Y. Moritani, "Quick System Design of Vesicle-Based Active Transport Molecular Communication by Using a Simple Transport Model," *Nano Communication Networks*, vol. 2, no. 4, pp. 175–188, 2011.

CONFERENCE
PAPERS

[C34] **N. Farsad**, and A. Goldsmith, "Sliding Bidirectional Recurrent Neural Networks for Sequence Detection in Communication Systems," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, accepted, 2018.

[C33] **N. Farsad**, M. Rao, and A. Goldsmith, "Deep Learning for Joint Source-Channel Coding of Text," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, accepted, 2018.

[C32] V. Jamali, **N. Farsad**, R. Schober, and A. Goldsmith, "Diffusive Molecular Communications with Reactive Signaling," *IEEE International Conference on Communications (ICC)*, accepted, 2018.

[C31] **N. Farsad**, D. Pan, and A. Goldsmith, "A Novel Experimental Platform for In-Vessel Multi-Chemical Molecular Communications," *IEEE Global Communications Conference (GLOBECOM)*, 2017.

[C30] Y. Murin, M. Chowdhury, **N. Farsad**, and A. Goldsmith, "Diversity Gain of One-shot Communication over Molecular Timing Channels," *IEEE Global Communications Conference (GLOBECOM)*, 2017.

[C29] C. Lee, H. B. Yilmaz, C.-B. Chae, **N. Farsad**, and A. Goldsmith, "Machine Learning based Channel Modeling for Molecular MIMO Communications," *IEEE International workshop on Signal Processing advances in Wireless Communications (SPAWC)*, 2017.

[C28] **N. Farsad**, C. Rose, M. Medard, and A. Goldsmith, "Capacity of Molecular Channels with Imperfect Particle-Intensity Modulation and Detection," *IEEE International Symposium on Information Theory (ISIT)*, 2017.

[C27] V. Jamali, A. Ahmadzadeh, **N. Farsad**, and R. Schober, "SCW Codes for Optimal CSI-Free Detection in Diffusive Molecular Communications," *IEEE International Symposium on Information Theory (ISIT)*, 2017.

[C26] **N. Farsad**, Y. Murin, M. Rao, and A. Goldsmith, "On the Capacity of Diffusion-Based Molecular Timing Channels with Diversity," *Asilomar Conference on Signals, Systems, and Computers*, 2016.

[C25] **N. Farsad**, Y. Murin, W. Guo, C.-B. Chae, A. Eckford and A. Goldsmith, "On the Impact of Time-Synchronization in Molecular Timing Channels," *IEEE Global Communications Conference (GLOBECOM)*, 2016.

[C24] Y. Murin, **N. Farsad**, M. Chowdhury, and A. Goldsmith, "Communication over Diffusion-Based Molecular Timing Channels," *IEEE Global Communications Conference (GLOBECOM)*, 2016.

[C23] V. Jamali, **N. Farsad**, R. Schober, and A. Goldsmith, "Non-Coherent Multiple-Symbol Detection for Diffusive Molecular Communications," *ACM International Conference on Nanoscale Computing and Communication (NanoCom)*, 2016.

[C22] Y. Murin, **N. Farsad**, M. Chowdhury, and A. Goldsmith, "On Time-Slotted Communication over Molecular Timing Channels," *ACM International Conference on Nanoscale Computing and Communication (NanoCom)*, 2016.

[C21] **N. Farsad**, Y. Murin, A. W. Eckford, and A. Goldsmith, "On the Capacity of Diffusion-Based Molecular Timing Channels," *IEEE International Symposium on Information Theory (ISIT)*, 2016.

[C20] **N. Farsad**, and Andrea Goldsmith, "A Molecular Communication System Using Acids, Bases and Hydrogen Ions," *IEEE International workshop on Signal Processing advances in Wireless Communications (SPAWC)*, 2016.

[C19] **N. Farsad**, H. B. Yilmaz, C.-B. Chae, and Andrea Goldsmith, "Energy Model for Vesicle-Based Active Transport Molecular Communication," *IEEE International Conference on Communications (ICC)*, 2016.

[C18] **N. Farsad**, W. Guo, C.-B. Chae, and A. W. Eckford, "Stable Distributions as Noise Models for Molecular Communication," *IEEE Global Communication Conference (GLOBCOM)*, 2015.

[C17] C. Lee, B. Koo, N.-R. Kim, H. B. Yilmaz, **N. Farsad**, A. W. Eckford, and C.-B. Chae, "Molecular MIMO with Drift," *International Conference on Mobile Computing and Networking (MobiCom)*, 2015.

[C16] S. Qiu, **N. Farsad**, Y. Dong, A. W. Eckford, and W. Guo, "Under-Water Molecular Signalling: a Hidden Transmitter and Absent Receivers Problem," *IEEE International Conference on Communications (ICC)*, 2015.

[C15] N.-R. Kim, **N. Farsad**, C.-B. Chae, and A. W. Eckford, "A Universal Channel Model for Molecular Communication Systems with Metal-Oxide Detectors," *IEEE International Conference on Communications (ICC)*, 2015.

[C14] L. Wang, **N. Farsad**, W. Guo, S. Magierowski, and A. W. Eckford, "Molecular Barcodes: Information Transmission via Persistent Chemical Tags," *IEEE International Conference on Communications (ICC)*, 2015.

[C13] C. Lee, B. Koo, N.-R. Kim, H. B. Yilmaz, **N. Farsad**, A. W. Eckford, and C.-B. Chae, "Molecular MIMO Communication Link," *IEEE International Conference on Computer Communications (INFOCOM)*, 2015.

[C12] N.-R. Kim, **N. Farsad**, C.-B. Chae, and A. W. Eckford, "A Realistic Channel Model for Molecular Communication with Imperfect Receivers," *IEEE International Conference on Communications (ICC)*, 2014.

[C11] S. Qiu, W. Guo, S. Wang, **N. Farsad**, and A. W. Eckford, "A Molecular Communication Link for Monitoring in Confined Environments," *IEEE International Conference on Communications (ICC) Workshops*, 2014.

[C10] **N. Farsad**, W. Guo, and A. W. Eckford, "Molecular Communication Link," *IEEE International Conference on Computer Communications (INFOCOM)*, 2014.

[C9] **N. Farsad**, A. W. Eckford, and S. Hiyama, "Modelling and Design of Polygon-Shaped Kinesin Substrates for Molecular Communication," *IEEE International Conference on Nanotechnology*, 2012.

[C8] **N. Farsad**, A. W. Eckford, and S. Hiyama, "A Mathematical Channel Optimization Formula for Active Transport Molecular Communication," *IEEE International Conference on Communications (ICC) Workshops*, 2012.

[C7] **N. Farsad**, A. Eckford, and S. Hiyama, "Channel design and optimization of active transport molecular communication," *Bio-Inspired Models of Networks, Information, and Computing Systems (BIONETICS)*, 2011.

[C6] A. Calce, **N. Farsad**, and A. W. Eckford, "An Experimental Study of Fractional Cooperation in Wireless Mesh Networks," *IEEE Symposium on Personal Indoor Mobile Radio Communications (PIMRC)*, 2011.

[C5] **N. Farsad**, A. Eckford, S. Hiyama, and Y. Moritani, "Information rates of active propagation in microchannel molecular communication," in *Bio-Inspired Models of Networks, Information, and Computing Systems (BIONETICS)*, 2010.

[C4] **N. Farsad**, A. W. Eckford, S. Hiyama, and Y. Moritani, "A Simple Mathematical Model for Information Rate of Active Transport Molecular Communication," *IEEE International Conference on Computer Communications (INFOCOM) Workshops*, 2011.

[C3] A. W. Eckford, **N. Farsad**, S. Hiyama, and Y. Moritani, "Microchannel Molecular Communication with Nanoscale Carriers: Brownian Motion versus Active Transport," *IEEE International Conference on Nanotechnology*, 2010.

[C2] **N. Farsad**, and A. W. Eckford, "Resource allocation via linear programming for multi-source, multi-relay wireless networks," *IEEE International Conference on Communications (ICC)*, 2010.

[C1] **N. Farsad**, and A. W. Eckford, "Low-complexity cooperation with correlated sources: diversity order analysis," *Annual Conference on Information Sciences and Systems (CISS)*, 2009.

PATENTS

[P1] **N. Farsad**, and Andrea Goldsmith, Systems and methods for transmitting data using machine learning classification, U.S. Provisional Patent 62/458,936, Feb. 14, 2017.

INVITED TALKS

[15] **N. Farsad**, "Detection Over Unknown Channels via Machine Learning," *2018 International Zurich Seminar on Information and Communication*, Zurich, Switzerland. (February 2018)

[14] **N. Farsad**, "Information Theoretic Limits of Molecular Communication and System Design Using Machine Learning," *IEEE Information Theory Society's Santa Clara Valley Chapter*, Stanford University. (October 2017)

[13] **N. Farsad**, and C. Rose, "Molecular Communication: System Models, Fundamental Limits, and Experimental Implementations," *IEEE Wireless Communications and Networking Conference*, **a conference tutorial**, San Fransisco, CA, USA. (March 2017)

[12] **N. Farsad**, "Molecular Communication: Theoretical Limits and Experimental Implementations", Department of Electrical and Computer Engineering, **University of British Columbia**, Vancouver, British Columbia. (June 2016)

[11] **N. Farsad**, "Capacity Limits of Diffusion-Based Molecular Timing Channels", **Canadian Biennial Symposium on Communications (BSC)**, Kelowna, British Columbia. (June 2016)

[10] **N. Farsad**, "Molecular Communication: Theoretical Limits and Experimental Implementations", School of Electrical and Computer Engineering, **Georgia Institute of Technology**, Atlanta, Georgia. (May 2016)

[9] **N. Farsad**, "Molecular Communication: Theoretical Limits and Experimental Implementations", Department of Electrical and Computer Engineering, **Carnegie Mellon University**, Pittsburgh, Pennsylvania. (May 2016)

[8] **N. Farsad**, "Molecular Communication: Theoretical Limits and Experimental Implementations", Department of Electrical and Computer Engineering, **Boston University**, Cambridge, Massachusetts. (May 2016)

[7] **N. Farsad**, "Molecular Communication: Theoretical Limits and Experimental Implementations", Department of Electrical Engineering and Computer Science, **Massachusetts Institute of Technology**, Cambridge, Massachusetts. (May 2016)

[6] **N. Farsad**, "Molecular Communication: Theoretical Limits and Experimental Implementations", **IEEE Toronto Section and University of Toronto**, Toronto, Ontario. (April 2016)

[5] **N. Farsad**, "Molecular Communication: Theoretical Limits and Experimental Implementations", Department of Electrical Engineering, **Princeton University**, Princeton, New Jersey. (April 2016)

[4] **N. Farsad**, "Capacity Limits of Molecular Timing Channels", **Information Theory and Applications (ITA) Workshop**, San Diego, California. (Feb 2016)

[3] **N. Farsad**, "Molecular Communication using Acids and Bases", Communications, Inference, And Computing In Molecular And Biological Systems Workshop, **University of Southern California**, USA. (December 2015)

[2] **N. Farsad**, "Tabletop Molecular Communication: Theory and Practice", School of Engineering, **University of Warwick**, United Kingdom. (September 2014)

[1] **N. Farsad**, "Molecular Communication", School of Integrated Technology, **Yonsei University**, South Korea. (November 2013)

TECHNICAL
REPORTS

[4] **N. Farsad**, and A. W. Eckford "Optimal Channel Design and Markov Chain Channel Model for Active Transport Molecular Communication," NTT DOCOMO Inc., Yokosuka, Kanagawa, Japan, March 2013.

[3] **N. Farsad**, and A. W. Eckford "Channel Design and Optimization in Active Transport Molecular Communication," NTT DOCOMO Inc., Yokosuka, Kanagawa, Japan, March 2012.

[2] **N. Farsad**, and A. W. Eckford "Information Transfer in Microchannel Systems: Effects of Flow and Mass Transport," NTT DOCOMO Inc., Yokosuka, Kanagawa, Japan, March 2011.

[1] **N. Farsad**, and A. W. Eckford "Mathematical Models of Information Transfer in Molecular Active Transport Systems," NTT DOCOMO Inc., Yokosuka, Kanagawa, Japan, March 2010.

TEACHING
EXPERIENCE

Lecturer
University of Ontario Institute of Technology, Greater Toronto Area
Advanced Communication Networks (graduate course, enrollment: 21)   Winter 2015
Signals and Random Processes (third-year course, enrollment: 45, evaluation: 78/100) Fall 2012
Signals and Random Processes (third-year course, enrollment: 46, evaluation: 86/100) Fall 2011
Teaching Assistant & Lab Instructor
York University, Toronto   2007–2015
Object Oriented Programming from Sensors to Actuators (first-year course, term/year: W15)
Signal and Systems (third-year course, term/year: F14, F11, F09)
Digital Communication (fourth-year course, term/year: F12, F10, F09)
Mobile Communications (fourth-year course, term/year: W14)
Embedded Systems (third-year course, term/year: W12, W08)
Fundamentals of Data Structures (second-year course, term/year: S13)
Introduction to Computing for Mathematics and Statistics (first-year course, term/year: W11)
Introduction to Computer Science I (first-year course, term/year: F09, F07)

PROFESSIONAL
SERVICE

Area Associate Editor
IEEE Journal on Selected Areas in Communication–2013 Special Issue on Emerging Technologies in Communications

Technical Program Committee
IEEE International Conference on Communication (ICC), 2015, 2018
IEEE Global Communications Conference (GLOBCOM), 2015, 2016, 2017
International Conference on Bio-inspired Information and Communications Technologies (BICT), 2015, 2016

Standardization Project
P1906.1 - Recommended Practice for Nanoscale and Molecular Communication Framework

Technical Reviewer
IEEE Transactions on Signal Processing
IEEE Transactions on Information Theory
IEEE Transactions on Nanotechnology
IEEE Transactions on Biomedical Engineering
IEEE Transactions on NanoBioscience
IEEE Journal on Selected Areas in Communication
IEEE Transactions on Communication
IEEE Communications Letters
IEEE Wireless Communications Letters
IEEE International Symposium on Information Theory (ISIT)

MEMBERSHIPS	Engineering Intern at Professional Engineers Ontario, since 2011
	IEEE Member, since 2007
	IEEE Communication Society Member, since 2007
	IEEE Information Theory Society Member, since 2007
	IEEE Signal Processing Society Member, since 2009
	IEEE Engineering in Medicine and Biology Society Member, since 2009

LIST OF
REFERENCES

Andrea Goldsmith
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