Abstract:
Networks play a central role in determining the outcomes of a variety of socio-technological and economic interactions. Examples include investing in security, sharing of congestible resources, and learning by teams of agents, in network environments. In this talk, I aim to analyze the role of information and incentives in distributed learning and decision making in such problems.
I will first discuss the role of information sharing in a multi-agent (reinforcement) learning problem. We study learning and decision making by agents who have heterogeneous information about their unknown, partially observable environment. We identify two benefits of information sharing between such agents: it facilitates coordination among them, and further enhances the learning rate of both better informed and less informed agents. We show however that these benefits will depend on the communication timing, in that delayed information sharing may be preferred in certain scenarios.
I will then present a framework for characterizing the effects of the network topology on strategic decision making over networks. Specifically, we establish a connection between the equilibrium outcomes of network games with non-linear (resp. linear) best-response functions, and variational inequality (resp. linear complementarity) problems. Through these connections, we outline conditions for existence, uniqueness, and stability of equilibria in these games, extending several existing results in the literature. We further discuss the effects of the network topology on the design of incentive mechanisms in such settings, with applications in improving cybersecurity.

Bio:
Parinaz Naghizadeh is a postdoctoral research associate in the Department of Electrical and Computer Engineering at Purdue University and Princeton University Edge Lab. She received her Ph.D. in electrical engineering from the University of Michigan in 2016, M.Sc. degrees in electrical engineering and mathematics, both from the University of Michigan, in 2013 and 2014, respectively, and her B.Sc. in electrical engineering from Sharif University of Technology, Iran, in 2010. Her research interests are in network economics, learning theory, game theory, reinforcement learning, and data analytics. She was a recipient of the Barbour Scholarship in 2014, a finalist for the ProQuest Dissertation Award in 2016, and a Rising Stars in EECS in 2017.
DEPARTMENT OF BIOLOGICAL SCIENCES
SEMINAR SERIES

Dr. David Ban
Sr. Scientist – Merck & Co.

“NMR Relaxation Dispersion: Evaluating and Ranking Functional Dynamics”

Monday, March 11, 2018
12:00 Noon
CBIS, Bruggeman Room
Class of '27 Lecture

"Gradient Decent Without Gradients"

Abstract: The core of continuous optimization lies in using information from first and second order derivatives to produce steps that improve objective function value. Classical methods such as gradient decent and Newton method rely on this information. The recently popular method in machine learning - Stochastic Gradient Decent - does not require the gradient itself, but still requires its unbiased estimate. However, in many applications either derivatives or their unbiased estimates are not available. We will thus discuss a variety of methods which construct useful gradient approximations, both deterministic and stochastic, from only function values. We will compare them in terms of computational cost and their accuracy. We will also present several motivating examples from Machine Learning, Reinforcement Learning and other modern applications.

Date: Monday, March 11, 2019
Time: 4:00pm—5:00pm
Place: Amos Eaton 214
Refreshments: 4th Floor Amos Eaton @ 3:30pm
Reception immediately following lecture,
4th Floor Amos Eaton @ 5:15pm
Host: Yangyang Xu
Protein droplet and ALS liquid-liquid phase separation of UBQLN2 is modulated by oligomerization, ALS-linked mutations, and ubiquitin binding

An emerging feature of many intrinsically-disordered proteins is that they demix from solution and form a protein-dense phase (liquid droplets) in equilibrium with a protein-dilute phase, a phenomenon generally known as liquid-liquid phase separation (LLPS). LLPS underlies the formation of biomolecular condensates such as stress granules. Stress granule persistence or disrupted stress granule dynamics is hypothesized to lead to the characteristic protein inclusions that are a hallmark of ALS (amyotrophic lateral sclerosis) and other neurological disorders. We recently found that Ubiquilin-2 (UBQLN2), an ALS-linked protein critical for maintaining protein quality control, is recruited to stress granules in vivo and undergoes LLPS in vitro under physiological conditions. UBQLN2 LLPS behavior is modulated by multivalent interactions involving its folded domains as well as the intrinsically-disordered STI1-II and proline-rich (Pxx) regions. Importantly, we showed that binding to ubiquitin or polyubiquitin eliminates UBQLN2 phase separation; this has potential implications for the role of UBQLN2 in shuttling ubiquitinated substrates to the proteasome or autophagy pathways. Mutations in the (Pxx) region of UBQLN2 cause ALS and ALS/dementia, but the molecular mechanisms for how these mutations cause disease are unknown or poorly understood. Since the Pxx region contributes to UBQLN2 LLPS, we hypothesized that Pxx mutations disrupt LLPS. Using spectrophotometric assays and microscopy, we show that a subset of these mutations at positions T487, P497 or P506 significantly enhance UBQLN2 LLPS and/or alter material properties of UBQLN2 protein droplets in vitro. Importantly, these UBQLN2 mutants still undergo LLPS reversibly. Biophysical experiments including NMR spectroscopy and analytical ultracentrifugation reveal that these single point mutations do not alter UBQLN2 structure, but likely promote UBQLN2 oligomerization, a prerequisite for LLPS. Our experiments suggest that disease-linked mutations modulate UBQLN2 LLPS, and potentially alter material properties of UBQLN2-containing biomolecular condensates in the cell, promoting disease states.
"Convergence Analysis of Stochastic Optimization Methods via Martingales"

Abstract: We will present a very general framework for unconstrained stochastic optimization which encompasses standard frameworks such as line search and trust region using random models. In particular this framework retains the desirable practical features such step acceptance criterion, trust region adjustment and ability to utilize of second order models. The framework is based on bounding the expected stopping time of a stochastic process, which satisfies certain assumptions. Then the convergence rates are derived for each method by ensuring that the stochastic processes generated by the method satisfies these assumptions. The methods include a version of a stochastic trust-region method and a stochastic line-search methods and provide strong convergence analysis under weaker conditions than alternative approaches in the literature.

Date: Tuesday, March 12, 2019
Time: 4:00pm—5:00pm
Place: DCC 330
Refreshments: 4th Floor Amos Eaton @ 3:30pm

Host: Yangyang Xu
“Systematic Study of Nucleosome-Displacing Factors in Budding Yeast”

Abstract

Nucleosomes present a barrier for the binding of most transcription factors (TFs). However, special TFs known as nucleosome-displacing factors (NDFs) can access embedded sites and cause the depletion of the local nucleosomes as well as repositioning of the neighboring nucleosomes. Here, we developed a novel high-throughput method in yeast to identify NDFs among 104 TFs and systematically characterized the impact of orientation, affinity, location, and copy number of their binding motifs on the nucleosome occupancy. Using this assay, we identified 29 NDF motifs and divided the nuclear TFs into three groups with strong, weak, and no nucleosome-displacing activities. Further studies revealed that tight DNA binding is the key property that underlies NDF activity, and the NDFs may partially rely on the DNA replication to compete with nucleosome. Single molecule biochemical study shows that at least some NDFs can bind stably to nucleosome, which may facilitate invasion into the nucleosome. Overall, our study presents a framework to functionally characterize NDFs and elucidate the mechanism of nucleosome invasion.
Biography

Dr. Bai is an associate professor in the Department of Biochemistry and Molecular Biology and Department of Physics at Penn State University. She received her PhD in biophysics from Cornell University (supervisor: Dr. Michelle Wang). For her thesis work, she combined single molecule experimental approaches with theoretical modeling to understand the thermodynamic and kinetic properties of a variety of biomolecules. She then worked as a postdoctoral fellow at Rockefeller University (supervisors: Dr. Fred Cross and Dr. Eric Siggia), using cell-cycle genes as a model to understand how promoter architecture and nucleosome positioning regulate gene expression in single cells. Dr. Bai moved to the Penn State University as an assistant professor in 2012, and was promoted to associate professor in 2018. The Bai Lab uses a variety of strategies to understand the mechanism of gene regulation by chromatin structure at different levels. Her current research has two major focus: (1) to identify and characterize factors that can lead to nucleosome depletion and (2) to mechanistically dissect long-distance chromosomal interactions that regulate gene expression. Budding yeast is used as the primary model system, but her lab is also venturing into the mammalian cells. Her lab is also developing new genetics and genomics tools for the projects above. Besides her dual appointment at BMB and Physics, her group is also part of the Penn State Center for Eukaryotic Gene Regulation, which provides a highly interactive environment for the study of chromatin and gene regulation.

Refreshments: 9:00 a.m., Coonley Lounge
"NASA’s Strategic Goals for Small Spacecraft Science"

Charles D. Norton
NASA Headquarters, Science Mission Directorate

Wednesday, March 13, 2019
10:30 AM – 11:30 AM
DCC 318

Abstract: Large strategic (Flagship) missions, like the Cassini-Huygens mission to Saturn, are a cornerstone of NASA’s strategy for exploring the deepest questions of Earth, Planetary Science, Heliophysics and Astrophysics science. These missions have fundamentally advanced human knowledge and much of our current scientific understanding of the universe at large is a result of such missions. Large missions, however, require large resources including time, funding, and people, and although they are arguably among the most successful exploration undertakings in history small spacecraft are now emerging as an additional capability to contribute unique science in a more time and cost-effective manner.

NASA’s Science Mission Directorate (SMD), in collaboration with other organizations in the agency, is aggressively developing small spacecraft as part of a balanced portfolio of focused high priority science missions. The agency has invested in CubeSat, SmallSat and constellation missions using these platforms to advance new remote sensing science missions responsive to the NASA Strategic Science Plan, as well as technology development in support of future science missions. This talk will review NASA’s portfolio, accomplishments, and future strategic directions for Earth and Space Science exploration using small satellites.

Bio: Charles D. Norton is the Special Advisor for Small Spacecraft Missions at NASA. In that role he is responsible for advising on NASA’s cross-agency strategic direction for innovative small satellite science, exploration, and technology missions from ESPA-Class spacecraft down to CubeSats. Previously, he was a Program Manager Associate at the Jet Propulsion Laboratory, California Institute of Technology where he developed and led multiple small spacecraft technology flight validation missions for NASA’s Earth Science Technology Office. Charles is a recipient of numerous awards for new technology and innovation, including the JPL Lew Allen Award, Voyager Award, and the NASA Exceptional Service Medal. He earned his BSE in Electrical Engineering and Computer Science from Princeton University and his MS and Ph.D in Computer Science from Rensselaer in high performance computational plasma physics modeling.
Conductivity via Cocontinuous Polymer Blends:
A Little Graphene Goes a Long Way

Chris Macosko
Department of Chemical Engineering & Materials Science
University of Minnesota

Abstract: Conductive polymer composites have been developed for electrostatic discharge and electromagnetic interference shielding. Loadings of >10% conductive fillers are typically required, but such loading levels result in high melt viscosity, poor appearance, contamination by sloughed off fillers and high material cost. We have found that small amounts of graphene nanoplatelets, 0.06 wt%, if located at the interfaces in a cocontinuous polymer blend, can percolate resulting in useful conductive composites. We will show how wetting properties as well as the kinetics of graphene movement during melt mixing can help to explain graphene jamming in the interfaces.

Bio: Chris Macosko is Director of the Industrial Partnership for Research in Interfacial and Materials Engineering and Professor of Chemical Engineering and Materials Science at the University of Minnesota and a member of the National Academy of Engineering. He received his B.S. from Carnegie Mellon, M.Sc. from Imperial College, London and Ph.D. from Princeton. He has advised over 100 M.S. and Ph.D. students and postdoctoral researchers with whom he has published over 500 papers in rheology and polymer processing. This research has been recognized with numerous awards including the Bingham medal of the Society of Rheology and election to the National Academy of Engineers. He co-founded Rheometric Scientific, now part of TA Instruments, which is a leading producer of rheological instruments. His rheology textbook "Rheology: Principles, Measurements, and Applications" (Wiley, 1994) is widely used.
The newly emerging field of optical wavefront shaping involves the ability to manipulate light fields both spatially and temporally. It has largely been enabled by the availability of spatial light modulators (SLM). SLMs are used to create arbitrarily complex light fields that are now powerful elements of the optics toolbox. An SLM provides means to manipulate the fundamental constituents of classical light or single photons, which obey the laws of quantum physics. These new tools open up novel ways to address topics where conventional optical techniques are hard to apply, such as the control of light propagation in biological tissues, complex photonic structures, plasmonic systems, and multimode fibers. In this talk, I outline how I will exploit the versatility of wavefront shaping to address challenges in biomedical imaging and to generate entangled structured light fields to address coherence degradation in optical communication transmission channels.
BIOMEDICAL ENGINEERING

“Tissue Engineering and Drug Delivery Approaches for Bone Regeneration”

Danielle Benoit, Ph.D.
University of Rochester

Thursday, March 14, 2019

2:30 pm

JEC 3117

The Therapeutic Biomaterials Laboratory at the University of Rochester focuses on the development of polymer therapeutics for orthopaedic tissue regeneration. There are myriad diseases of the skeleton that require regenerative approaches including bone grafts, osteoporosis, or delayed union or nonunion fractures. Specifically, in the case of allograft procedures, which are the ‘gold standard’ for massive bone defects, there exists a 60% failure rate within 10 years of implantation due to poor graft-host integration and microcrack propagation. Unlike allografts, autografts fully heal and integrate, mediated by the periosteum, a thin layer of osteogenic tissue surrounding bone. To enhance allograft healing as well as understanding the fundamental requirements for healing, we have pioneered the development of a tissue-engineered periosteum. Specifically, a hydrolytically degradable poly(ethylene glycol) (PEG)-based tissue engineering periosteum (TEP) with entrapped mesenchymal-origin progenitor cells. Using this approach, the TEP augments graft healing, as measured via increased graft vascularization, endochondral bone formation, and biomechanical strength, as compared to untreated allografts. Unfortunately, TEP-mediated healing still falls behind autografts and is highlighted by persistent fibrotic callus that ultimately results in 50% lower maximum torque values at 9 weeks post implantation. To investigate the differences in healing, hypoxia was evaluated at acute time points after surgery. Significantly higher hypoxia levels were observed in TEP-modified allografts versus autografts over three days post-surgery. We hypothesize that poor acute vascular infiltration causes hypoxia which then alters the healing cascade, underpinning fibrosis. Thus, promoting early angiogenesis and vascular perfusion of the TEP is a focus of our current efforts. As it is known that bulk hydrolytic degradation of matrix limits the migration, proliferation, and remodeling by host endothelial cells (ECs), the degradation
mechanism of TEP hydrogels has been our first area of focus. Exploiting MMP-degradable hydrogels-based TEP shows increases in bone callus volume, callus bridging, and blood vessel formation at 3 week post-surgery versus hydrolytically-degradable counterparts. We are also exploring the mechanism of transplanted cells and infiltrating endothelial cells in graft healing, with a focus on paracrine and angiocrine factors to potentiate a cell-free revitalization approach. Taken together, this work strives to advance our understanding of how the periosteum coordinates allograft healing and the design of regenerative strategies to promote bone healing.

Danielle Benoit is Associate Professor within the Department of Biomedical Engineering with appointments also in Chemical Engineering and the Center for Musculoskeletal Research at the University of Rochester. She directs the Therapeutic Biomaterials Laboratory, which specializes in the rational design of polymeric materials for regenerative medicine and drug delivery applications. Her work has provided insights into the translation of tissue engineering strategies for bone allograft repair, development of pH-responsive nanoparticles for nucleic acid and small molecule drug delivery, and novel targeting strategies for bone-specific delivery of therapeutics. Prof. Benoit has been recognized by numerous awards and accolades for her research program including 2019 Class of AIMBE Fellows, the 2018 University of Maine Distinguished Alumni Award, the 2016 Kate Gleason Young Engineer of the Year Award, a 2015 Young Innovator Award in Cellular and Molecular Bioengineering, an NSF CAREER Award, and Alex’s Lemonade Stand Young Investigator Award. She is also a standing member of the NIH Biomaterials and Biointerfaces Study Section. Prof. Benoit received her undergraduate degree in Biological Engineering from the University of Maine and M.S. and Ph.D. in Chemical Engineering from the University of Colorado, where she was mentored by Dr. Kristi Anseth. She then trained at the University of Washington where she was a Damon Runyon Cancer Research Foundation Postdoctoral Fellow, working with Drs. Patrick Stayton and Allan Hoffman. Prof. Benoit joined the faculty at the University of Rochester in 2010.