DEPARTMENT OF BIOLOGICAL SCIENCES
SEMINAR SERIES

Dr. Sozanne Solmaz
State University of New York - Binghamton

“Cell Cycle Specific-Recognition of the Nucleus as Cargo for Dynein-Dependent Transport”

Monday, February 25, 2018
12:00 Noon
CBIS, Bruggeman Room

REFRESHMENTS SERVED 11:45
Raman spectroscopy combined with advanced statistics has a great potential for becoming a universal tool for a variety of practical applications including forensic science and medical diagnostics. Raman spectroscopy is already used in crime laboratories as a confirmatory tool. The technique is non-destructive, rapid and requires little or no sample preparation. Furthermore, portable Raman instruments are readily available allowing for crime scene accessibility. We have recently demonstrated that Raman microspectroscopy can be used for the identification of biological stains at a crime scene indicating the type of body fluid. In addition, peripheral and menstrual blood as well as human and animal blood can be differentiated. The time since deposition of bloodstain can be estimated up to two years. Most recently, we demonstrated the proof-of-concept for phenotype profiling based on Raman spectroscopy of dry traces of body fluids including the determination of sex, race and age of the donor. Raman microscopy has a great potential for the detection and characterization of gunshot residue (GSR). We have demonstrated that both organic and inorganic GSR particles could be detected on an adhesive tape. The ability to differentiate GSR particles originated from different firearm-ammunition combinations was also shown. The ultimate long-term goal of this project is to develop a novel, non-destructive, easy-to-use and rapid technique for the detection and characterization of GSR. We will discuss a new patented approach for disease diagnostics based on Raman hyperspectroscopy and advanced statistics. Near infrared (NIR) Raman hyperspectroscopy of blood serum was utilized for differentiating patients diagnosed with Alzheimer’s disease, other types of dementia and healthy control subjects with more than 95% sensitivity and specificity. When fully developed, this fast, inexpensive noninvasive method could be used for screening at risk patient populations for AD development and progression.
“Peptides and Peptide Mimetics. A Galaxy of Properties and Applications”

Abstract

Peptides and peptide mimetics are an exciting and growing class of versatile molecules. Their chemical and structural diversity makes them capable of performing an unimaginable variety of tasks, from protein- and cell-binding, to stimuli-responsive phase transitions in solution, to complexing metals, and so on. They are easy to synthesize, relatively cheap, and fun to work with. In one talk, it is not possible to cover it all, but I will present a selection of three topics that I hope will resonate with your expertise at RPI, that is affinity ligands for protein purification, biorecognition moieties with mechanically-editable binding strength, light-controlled cell binding/unbinding, and model thermo-responsive poly-peptides.

Biography

Dr. Menegatti is an assistant professor in Chemical and Biomolecular Engineering at NC State University. He returned to NC State, where he earned his Ph.D. under the supervision of Prof. Ruben G. Carbonell, after two years as postdoctoral fellow at UC Santa Barbara with Prof. Samir Mitragotri. His doctoral work focused on peptide affinity ligands for the purification of antibody therapeutics and the development of biosensors. As a postdoc, he worked on cell mimetics, targeted delivery of synergistic combinations of anticancer drugs, and skin-permeating peptides. At NC State, which he joined in 2015, Stef is building a research group that investigates the physicochemical and biophysical properties of peptides and peptide mimetics (e.g., peptoids). Current work includes (i) peptide ligands for the purification of proteins and cells, (ii) tunable biosensors, (iii) light-responsive and thermo-responsive peptides, and (iv) peptide-metallic catalysts for pharmaceutical chemistry. He founded the company LigaTrap, which commercializes chromatographic adsorbents for antibody purification. In his free time, Stef tries to keep a 30-year-old tradition of salame-making alive. His website is: biopep.wordpress.ncsu.edu

Refreshments: 9:00 a.m., Coonley Lounge
"Next Generation Soft Surgical and Wearable Robots using High Torque Density Actuators"

Professor Hao Su
Dept. of Mechanical Engineering
City College of New York

Wednesday, February 27, 2019
10:30 AM – 11:30 AM
DCC 318

Abstract: This talk presents our efforts to invent high torque density actuators and how this technology will create a new paradigm of actuation design for co-robots. Our miniaturized surgical robots augment the vision and manipulation of surgeons to perform neurosurgery as it is MRI-compatible and highly dexterous. Unlike conventional exoskeletons that are rigid and heavy, our soft exoskeletons use soft materials to provide a conformal and unobtrusive means to interface to the human body. The talk describes our innovation in new actuation paradigm, soft sensors, and control approaches that deliver biologically-inspired assistance and how this tackles the grand challenges to reduce the human walking energetics and home-based neurorehabilitation.

Bio: Hao Su is an assistant professor in the Department of Mechanical Engineering at the City College of New York. He was a postdoctoral research fellow at Harvard University and the Wyss Institute for Biologically Inspired Engineering. Prior to this role, he was a Research Scientist at Philips Research North America where he designed robots for lung and cardiac surgery. He obtained the Ph.D. degree on Surgical Robotics from the Department of Mechanical Engineering at Worcester Polytechnic Institute. Dr. Su and his team won the Toyota Mobility Unlimited Discovery Award.

Dr. Su received the Best Medical Robotics Paper Runner-up Award in the IEEE International Conference on Robotics and Automation (ICRA) and Philips Innovation Transfer Award. He received the Advanced Simulation & Training Award from the Link Foundation and Dr. Richard Schlesinger Award from the American Society for Quality. He holds patents on surgical robotics and socially assistive robots.

Dr. Su is the Junior Chair of the Technical Committee on Mechanisms and Design of the IEEE Robotics and Automation Society (RAS). He is the Associate Editor of the Journal: Frontiers in Robotics and AI. He is the Associate Editor of the IEEE International Conference on Robotics and Automation and the BioRobotics theme editor of the IEEE Engineering in Medicine and Biology Society (EMBC). He is the Exoskeleton Standardization Task Force member of the National Institute of Standards and Technology (NIST). He was the chair of Catheter Robotics workshop and organizing committee member of the Design of Medical Devices Conference.
Translating Chemical Reactions and Catalysis to Nano-Electronic Sensors

Timothy M. Swager
Department of Chemistry
Massachusetts Institute of Technology

Abstract: This lecture will detail the creation of ultrasensitive sensors based on carbon nanotubes (CNTs). A central concept that a single nano- or molecular-wire spanning between two electrodes would create an exceptional sensor if binding of a molecule of interest to it would block all electronic transport. Nanowire networks of CNTs provide for a practical approximation to the single nanowire scheme. These methods include abrasion deposition and selectivity is generated by covalent and/or non-covalent binding selectors/receptors to the carbon nanotubes. Sensors for a variety of materials and cross-reactive sensor arrays will be described. A current limitation to most, if not all sensors, is chemical selectivity. Synthetic receptors can give some selectivity and when they have 3D structures can be highly specific for recognition of a molecule. However, translating complex molecular constructions into strong readable sensory signals is challenging. I will give multiple examples of how established chemical reactions that occur in solution can be used to create highly specific and sensitive sensors. There is a vast opportunity in translating the products of synthetic and catalytic chemistry into selective chemiresistive sensors. I will highlight the utility of CNT-based gas sensors for the detection of alkenes and other gases relevant to agricultural and food production/storage/transportation are being specifically targeted and can be used to create systems that increase production, manage inventories, and minimize losses.
**Biosketch:** Timothy M. Swager is the John D. MacArthur Professor of Chemistry and the Director, Deshpande Center for Technological Innovation at the Massachusetts Institute of Technology. A native of Montana, he received a BS from Montana State University in 1983 and a Ph.D. from the California Institute of Technology in 1988. After a postdoctoral appointment at MIT he was on the chemistry faculty at the Univ. of Pennsylvania and returned to MIT in of 1996 as a Professor of Chemistry and served as the Head of Chemistry from 2005-2010. He has published more than 400 peer-reviewed papers and more than 70 issued/pending patents. Swager’s honors include: Election to the National Academy of Sciences, an Honorary Doctorate from Montana State Univ., the Linus Pauling Medal, the Lemelson-MIT Award for Invention and Innovation, Election to the American Academy of Arts and Sciences, The American Chemical Society Award for Creative Invention, and The Carl S. Marvel Creative Polymer Chemistry Award (ACS). Swager’s research interests are in design, synthesis, and study of organic-based electronic, sensory, high-strength, liquid crystalline, and colloid materials. His inventions have had wide ranging commercial impact, including the Fido™ sensors, which are the world’s most sensitive explosives detectors. He is the scientific founder of 5 companies (DyNuPol, Iptyx, PolyJoule, C₂ Sense, and Xibus Systems) and has served on numerous of corporate and government boards.
Recent years have seen data-driven algorithms deployed in increasingly high-stakes environments. These algorithms are often highly complex, making them effectively “black boxes”; this potentially exposes various stakeholders (such as end-users, or the agencies deploying them) to risks, such as unfair treatment or inadvertent data breaches. In response, government agencies and professional societies have highlighted fairness and transparency as key design paradigms in AI/ML applications.

In this talk I will discuss our recent work on the mathematical foundations of algorithmic transparency and fairness. From the transparency perspective, I will discuss how we design transparency measures that are guaranteed to satisfy certain natural desiderata; in addition, I will discuss a recent line of work showing how some natural transparency measures may be used by an adversary in order to extract private user information. Regarding fairness, I will discuss how we apply fairness paradigms to algorithms, in particular our work on designing and deploying fair allocation algorithms; our results show that humans respond well to provably fair algorithms, and are willing to collaborate effectively even in strategic domains. Finally, I will discuss how we apply learning-theoretic approaches to fairness via a novel paradigm for adapting game-theoretic solution concepts in data-driven domains.

Bio: Yair Zick is an assistant professor at the Department of Computer Science at the National University of Singapore. He obtained his PhD (mathematics) from Nanyang Technological University, Singapore in 2014, and a B.Sc (mathematics, "Amirim" honors program) from the Hebrew University of Jerusalem. His research interests include computational fair division, computational social choice, algorithmic game theory and algorithmic transparency. He is the recipient of the 2011 AAMAS Best Student Paper award, the 2014 Victor Lesser IFAAMAS Distinguished Dissertation award, the 2016 ACM EC Best Paper award, and the 2017 Singapore NRF Fellowship.
The Department of Electrical, Computer and Systems Engineering
THE DOUGLAS MERCER ’77 ECSE LECTURE SERIES
A Distinguished Lecture

Srinivasa Ramanujan and Digital Signal Processing

P. P. Vaidyanathan

Kiya and Eiko Tomiyasu Professor of Electrical Engineering
California Institute of Technology

WEDNESDAY, FEBRUARY 27 at 4:00 PM in DCC-318
REFRESHMENTS SERVED AT 3:30 PM

The great Indian mathematician Srinivasa Ramanujan introduced a summation in 1918, called the Ramanujan-sum. For many years this summation was used by mathematicians to prove important results in number theory. In recent years, some researchers have found applications of this sum in digital signal processing, especially in identifying periodic components of signals buried in noise. In our recent work we have generalized the Ramanujan-sum decomposition in several directions, and this has opened up some new theory as well as applications. Many beautiful properties are enjoyed by the new representations, thanks to the genius and vision of Ramanujan. In this talk we briefly talk about Ramanujan as a person and then give an overview of the new developments. Applications in the study of DNA and protein sequences will be presented among others.

P.P. Vaidyanathan is the Kiyo and Eiko Tomiyasu Professor of Electrical Engineering at the California Institute of Technology where he has been on the faculty since 1983. He also served as the department head for the period 2002–2005. He has authored more than 500 papers in the areas of digital signal processing and communications, and several of his papers have received prizes from the IEEE. He is the author/coauthor of the four books, and a Fellow of the IEEE. Some of his recognitions include the F.E. Terman Award of the American Society for Engineering Education, the IEEE CAS Society’s Golden Jubilee Medal, and several awards for excellence in teaching at the California Institute of Technology, including the Northrop-Grumman prize for excellence in teaching. He has also received the IEEE Signal Processing Society’s Technical Achievement Award, Education Award, and the “Society Award.” He received the IEEE Gustav Robert Kirchhoff Award (an IEEE Technical Field Award) in 2016, for “Fundamental contributions to digital signal processing.” He was elected to the U.S. National Academy of Engineering in 2019.
“Calculating with Entanglement: Quantum Computing for Nuclear and Particle Physics”

Studying nature directly from fundamental degrees of freedom is often computationally limited by physical characteristics of exponentially growing configuration (Hilbert) spaces with particle number and signal-to-noise problems. This leaves many systems of interest to nuclear and particle physics intractable for known algorithms with current and foreseeable classical computational resources. By leveraging their natural capacity to describe nature, the use of quantum systems themselves to form a computational framework leads to constructions of basic quantum field theories with resource requirements that are expected to scale only polynomially with the precision and size of the system. In this talk, I will present an overview of recent progress in, and the potential for, manipulating controllable quantum devices to pursue computational access to our microscopic descriptions of nature.
Joining of dissimilar materials is a fundamental challenge in engineering. Nature presents a highly effective solution at the attachment of tendon to bone ("enthesis") in the rotator cuff of the shoulder's humeral head. The natural enthesis does not regrow following healing or surgery, resulting in inferior tissue and in post-surgical tear recurrence rates as high as 94%. Pressing needs exist both to understand the mechanobiology of adhesion and toughening across hierarchical scales in the healthy enthesis, and to reconstitute these in healing.

Our results show the tendon to bone insertion to be a hierarchical, heterogeneous, disordered system that uses randomness to tailor strain fields, and to maximize the fraction of tissue involved in resisting injury-level stresses. Based upon this model, we are developing two new mechano-medicine products for clinical translation: a diagnostic technology to evaluate the degree to which an enthesis is succeeding in physiological strain redistribution, and a repair technology that mimics the mesoscale function of the healthy enthesis by maximizing the fraction of tissue involved in resisting injury-level stresses. This talk will summarize our understanding of the mechanics of tendon-to-bone attachment, and describe repair and imaging technologies under development that harness this with the goal of providing improved surgical outcomes.
Guy M. Genin studies the mechanobiology of interfaces and adhesion. He is the Harold and Kathleen Faught Professor of Mechanical Engineering at Washington University in St. Louis, serving on the faculties of Mechanical Engineering & Materials Science, Biomedical Engineering, and Neurological Surgery. He is also Thousand Talents Plan Professor of Life Sciences at Xi’an Jiaotong University in Xi’an, China, and co-director of the Center for Engineering Mechanobiology, a joint NSF Science and Technology Center between Penn, Washington University, with several satellite sites. Prof. Genin serves as chief engineer for Washington University’s Center for Innovation in Neuroscience and Technology and is active in several start-ups. He co-chairs the NIH/Interagency Modeling and Analysis Group’s working group on integrated multiscale biomechanics experiment and modeling. Prof. Genin’s training includes B.S.C.E. and M.S. degrees from Case Western Reserve University, S.M. and Ph.D. degrees in solid mechanics from Harvard, and post-doctoral training at Cambridge and Brown. Prof. Genin is the recipient of a number of awards for engineering design, teaching, and research, including a Research Career Award from the NIH, the ASME Skalak Medal, and the Changjiang Scholar Award from the Chinese Ministry of Education. He is a fellow of ASME and AIMBE.
Abstract

Among the next generation of technologies, we expect medical diagnostic devices that are more accurate and portable; electronic devices that are faster, smaller, and capable of storing more information; and energy sources that are cleaner without sacrificing capacity or power. Polymers with tunable nano- and micro-structured morphologies can address these challenges. With this motivation in mind, I will present my group’s work on tuning the nano-scale domain sizes of block copolymer materials through polymer-polymer blending. In the first part of the talk, I will discuss simulations and experiments in which a block copolymer is blended with homopolymers corresponding to the blocks of the parent copolymer; these blends allow us to increase nanostructure size. The simulations are validated against experiment and provide insight into the molecular-level chain packing within the nanostructures that are formed. Additional thin film experiments demonstrate how surface interactions lead to different phase behavior from the bulk due to segregation of one of the homopolymer components to the substrate and free air interfaces. In the second part of the talk, I will discuss simulations and experiments in which block copolymers with linear and cyclic chain architectures are blended to decrease nanostructure size. Cyclic block copolymers exhibit nanostructure domain sizes 20-50% smaller than linear counterparts of equivalent molecular weight, and in this work, simulation-predicted domain sizes are used to select synthesis targets for our experimental work. Simulation work is performed in collaboration with Dr. Hank Ashbaugh (Tulane Chemical Engineering).

Biography

Julie N. L. Albert received her B.S. in Chemical Engineering from the University of Florida in 2005 and her Ph.D. in Chemical Engineering from the University of Delaware in 2012. Subsequently, she pursued postdoctoral research studies at North Carolina State University. Albert’s primary research interests are centered on engineering nano- and micro-structured block copolymer and semi-crystalline polymeric materials for applications related to technology development in the energy, health, and environmental sectors. During her doctoral studies, Albert received an NSF Graduate Research Fellowship and a Teaching Fellowship, and during her postdoctoral studies, she received the AIChE Women’s Initiative Committee Travel Award in 2012. As a faculty member, in 2015, she was selected for a prestigious Early-Career Research Fellowship by the National Academy of Sciences Gulf Research Program to develop nanoporous membranes for enhanced oil recovery from spills. In 2016 she was awarded a National Science Foundation Early-Career Development Program Grant (NSF-CAREER) to study the effects of solvent vapor processing on polymer thin film morphology. In addition to her research-related activities at Tulane, Julie also serves as the faculty advisor for the undergraduate Society of Women Engineers (SWE) and the graduate Women” in Science and Engineering student organizations on campus. In 2017, she was selected for the Academic Leadership for Women in Engineering (ALWE) Program and an ASSIST Travel Grant to attend the workshop held during the SWE National Conference.
Many important problems involve decision making under uncertainty. Namely, choosing options based on imperfect observations, with unknown outcomes. Multi-armed bandit is a simple yet quite useful framework of the algorithmic decision making under uncertainty. A decision-maker faces an “exploration vs. exploitation” dilemma. On the one hand, the decision-maker attempts to exploit the information that he or she has gathered up to now. On the other hand, the decision-maker desires information to improve the quality of their decision in the future. The framework has many practical applications such as the cold-start problem in a recommendation system and game-tree search in abstract games. A widely-used idea for this framework is to use the upper confidence bound (UCB), which gives additional value on options of high uncertainty. For instance, the state-of-the-art Game-of-Go algorithms, such as AlphaGo by Deepmind, adapts some variant of UCB.

In this talk, I will address two of my major challenges in this topic. (i) The efficiency of the Thompson sampling (TS), the oldest heuristic algorithm proposed in the 1930s: Regarding this topic, we show that TS is as efficient as the best version of UCB. (ii) The limitation of value function based approaches: I derive that UCB and TS are not always efficient by showing some examples where these value function approaches are not successful. I show that the efficiency of information can be represented as an optimization problem corresponding to the model structure, and invent an algorithm based on the optimization.

Bio: Junpei Komiyama is a research associate at the University of Tokyo, Institute of Industrial Science. He received a Ph.D. from the University of Tokyo in 2016. He belongs to machine learning and data mining communities. His research interest lies in data-driven decision making, and the research topics include multi-armed bandits, experimental design, statistical testing, optimization, computational economics, and algorithmic fairness.