Columbia University Expands and Strengthens High-Risk Interdisciplinary Research Collaborations

RISE competition identifies five teams to receive funding for innovative research partnerships.

NEW YORK, April 9, 2018—Columbia University's Office of the Executive Vice President for Research announced today that five teams will receive funding through **Research Initiatives in Science and Engineering** (RISE), one of the largest internal research grant competitions within the University. The annual award provides funds for interdisciplinary faculty teams from the basic sciences, engineering, and/or medicine to pursue extremely creative and interdisciplinary research projects. Each team's award is worth $80,000 per year for up to two years.

The RISE competition was created in 2004 to provide Columbia faculty and research scientists with the initial funding necessary to explore paradigm-shifting and high-risk ideas. Amidst an increasingly competitive funding climate for the STEM disciplines, researchers are increasingly challenged to provide more conclusive initial proofs of concept. In this competition, Columbia follows the National Institutes of Health's definition of high-risk research as having "an inherent high degree of uncertainty, and the capability to produce a major impact on important problems."

"Institutional support of research innovation is critically important, both broadly and specifically at Columbia University, says **G. Michael Purdy**, Executive Vice President for Research, and Professor of Earth and Environmental Sciences. "Over **15 other seed funding competitions** across the University span a wide range of disciplines, and support basic, translational, and/or applied research. As increasing competition for external funding biases awards towards more certain outcomes, RISE prompts our world-class researchers to ask highly-novel questions and propose new methodologies, and catalyzes cross-school collaborations. I look forward to what promises to be a great set of important investigations from these newly-awarded teams."

The 2018 competition accepted 29 pre-proposals, thereafter inviting nine teams to submit full proposals. Between six and nine reviewers evaluated each full proposal's interdisciplinary quality, potential impact, and innovation.

"It is never easy to select so few projects from so many extraordinary proposals," says **Victoria Hamilton**, Executive Director of Research Initiatives, and administrator of RISE. "This year alone, 90 reviewers generously lent expertise to help select the high-risk, high-reward proposals that RISE seeks to seed. Some of these five projects—just like some of the previously-awarded projects—may not result in the substantial discovery and impacts that they targeted, but this is the hallmark of risky research. Whereas only approximately half of the awarded projects go on to receive extramural funding, that subsequent funding totals six times the amount Columbia has invested in RISE. We are excited by each of the teams and their ambitious investigations, and we enthusiastically await the remarkable discoveries that these teams will make over the coming years."

2018 RISE AWARDEES

Entropic forces and SNARE protein ubiquitination in synaptic transmission and plasticity
Clarissa Waites (Pathology and Cell Biology/Neuroscience)
Ben O'Shaughnessy (Chemical Engineering)

Cognition, sensation, and coordinated motor activity rely on tightly-controlled release of chemical neurotransmitters at synapses, the basic units of communication in the brain. Establishing how neurotransmitter release at synapses is regulated in neural circuits for memory storage and complex behavior is a major challenge for neuroscience, and has important implications for treating neurodegenerative and neurodevelopmental disorders. This innovative project, uniting the efforts of two Columbia investigators with complimentary areas of expertise, investigates the molecular underpinnings of NT release. An integrated program of experiments and mathematical modeling will be used to test a novel hypothesis about how neurotransmitter release is dynamically regulated to achieve rapid, efficient synaptic communication.

Evolution in the Arctic: Genomic reconstruction of microbial, plant and animal communities during the Holocene

Jeffrey Shaman (Environmental Health Sciences)
Jonathan Nichols (Lamont-Doherty Earth Observatory)
Simon Anthony (Epidemiology)
Natalie Boelman (Lamont-Doherty Earth Observatory)
Dorothy Peteet (Lamont-Doherty Earth Observatory)

Using samples extracted from a well-dated, continuous 12,000-year record of Arctic permafrost soil, we will perform deep DNA sequencing and metagenomics to characterize bacterial, viral, fungal, plant and animal communities through time. By characterizing this ancient genetic material, we will begin to: 1) understand microbial evolution on 1,000-10,000 year timescales, and 2) examine how microbial, plant, and animal assemblages changed in conjunction with one another and in response to environmental disruption and climate variability. We will use these findings to determine how such community change has affected tundra environment carbon storage in the past and present, as well as to inform predictions of the future impact of this ecosystem on the global carbon cycle.

Novel devices for uncovering principles of active sensory processing

Nate Sawtell (Neuroscience)
John Kymissis (Electrical Engineering)

Studies of sensory systems have focused on measuring neural responses to artificial sensory stimuli delivered to passive subjects, that is, in isolation from behavior and motor systems. This approach is remote from natural situations in which an animal's own behavior exerts a profound impact both on the quality and quantity of the sensory input acquired and its central processing. Deep insights into the neural bases of sensation, movement, and cognition will likely require studying neural systems under circumstances relevant to those in which they evolved, i.e., during behavior in realistic, complex environments. This proposal combines the electronics, miniaturization, and device development expertise of the Kymissis group and the circuits neuroscience expertise of the Sawtell lab to develop new approaches for studying the electrosensory and auditory systems in freely behaving animals. In addition to providing insights into fundamental issues in sensory neurobiology these efforts are expected to have major impacts on engineering, particularly with respect to robotics and artificial sensing systems. To date, the active sensing capabilities of animals far exceed those of artificial systems. A better understanding of how animals move and sense so effectively will help to bridge this gap.

An Integrative Approach for Tracing Parallel Visual Pathways in the Non-human Primate Brain

Vince Ferrera (Neuroscience)
Tommy Vaughan (Biomedical Engineering)
Niko Kriegeskorte (Psychology)

The human cerebral cortex contains over 30 different regions that are involved in visual perception and visually-guided behavior. Each of these regions is specialized for a particular visual function such as seeing motion, color, or shape, coordinating eye and hand movements, or recognizing faces. These visual regions receive input from the eye that travels along subcortical neural pathways that are also specialized. One pathway is fast, coarse, and color-blind, while the other is slow, fine-grained, and color-selective. The relationship between the subcortical pathways and the functional specializations of the visual cortex has remained a mystery for over 30 years. This project will map visual information processing across the entire brain using a unique combination of functional neuroimaging and targeted manipulation of neural activity using chemical and optogenetic approaches. These experiments will provide new information on how information is transformed as it travels from eye to brain and thus gives rise to our ability to perceive and interact with the visual environment. The approach also can be generalized for studying information flow in other neural circuits.

Acceleration of Deep Neural Networks via Heterogeneous Computing for Real-Time Processing of Neutrino and Particle-Trace Imagery
Georgia Karagiorgi (Physics)
Luca Carloni (Computer Science)

This physics and computer science collaborative R&D project aims to develop a data processing system that can facilitate real-time processing and accurate classification of images streamed at rates on the order of terabytes per second. The primary target application is the future Deep Underground Neutrino Experiment (DUNE). This is a major international particle physics experiment that will be operational in the U.S. for more than a decade, beginning in 2024, and will be continually streaming high-resolution 3D images of the active detector region at a total data rate exceeding 5 terabytes per second. The ability to process this data in real time and to efficiently identify and accurately classify interesting activity in the detector would enable the discovery of rare particle interactions which have never been observed before. This ability however requires the development of an advanced data processing system. This RISE project aims to develop a scalable heterogeneous computing system that employs machine learning for identification and classification of interesting activity in the data. The ultimate goal is to leverage recent advancements in computer science to render the DUNE experiment a powerfully sensitive instrument for fundamental particle physics discovery.

PROGRAMMATIC IMPACT

RISE not only awards critical seed funding for risky and interdisciplinary collaborations; once the funding has ceased, the program tracks how its seed funding contributes to the researchers' abilities to obtain subsequent sponsorship from government agencies and private foundations.

Since 2004, RISE has awarded $9.62 million to 72 projects. These 72 teams later secured more than $55.4 million from governments and private foundations: a 600% return on Columbia's initial investment. These projects have additionally garnered more than 130 peer-reviewed publications and educated more than 130 postdoctoral scholars and graduate, undergraduate, and high school students. A complete list of **RISE-funded researchers** is available online.

RISE's goals are exemplified by the comments of **Georgia Karagiorgi**, Assistant Professor of Physics and 2018 RISE awardee. "My project with **Luca Carloni** aims to develop machine learning techniques and explore deep neural network implementations for 'listening' to only the most important and rare physics signals, and disregarding environmental noise and other accidental background signals. We are in the midst of a Big Data revolution, wherein our capacity to generate data greatly exceeds our ability to analyze and make sense of everything. In my own discipline of particle physics, we think that there is a great deal of information hidden in astroparticle data sets, such as those that will be recorded by the DUNE experiment. But we will need advanced methods and powerful systems to scan through those data sets and efficiently and accurately fish out the information we care about. This project requires interdisciplinary collaboration between physics and computer science, and time – afforded by RISE – to explore our early-stage ideas. If we can develop a system for only capturing the most important data, this is a project that can feasibly capture the attention of the National Science Foundation or the Department of Energy."

Applications for the **2019 competition** will run from September to early-October 2018, with five to six awarded teams announced by spring 2019.

For interview requests and additional information, or to partially- or fully-fund a new RISE project, contact Marley Bauce (**marley.bauce@columbia.edu**; 212-854-7836).

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About the Office of the Executive Vice President for Research

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