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Scientists Challenged to Create Better Tools for Image Analysis

The Allen Institute for Brain Science, the Howard Hughes Medical Institute (HHMI), and the Krasnow Institute for Advanced Study at George Mason University are launching an international scientific challenge to speed development of new computational tools that accurately and automatically reconstruct the “shape” of brain cells from available light microscopy data.

The organizers hope the DIADEM Challenge—short for Digital Reconstruction of Axonal and Dendritic Morphology—will lead to innovative solutions to a frustrating problem that has slowed efforts to create a functional atlas of the brain. Neuroscientists agree that a systematic characterization of neurons with their dendrites and axons is essential, since these tree-like structures are highly correlated with the electric activity of, and precise connections between, neurons and are thus linked to the functions of specific brain circuits. But scientists currently spend weeks—and, in some cases, months—tracing the intricate neuronal processes by hand, using data supplied by imaging studies.

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- Giorgio A. Ascoli

“Manual tracing of neurons has created an intolerable bottleneck and is currently limiting the pace of discovery in neural circuit analysis,” said Giorgio A. Ascoli of the Krasnow Institute for Advanced Study. “Automating this process will open the exciting path to the comprehensive characterization of neuronal structure and connectivity.”

The DIADEM Challenge is open to individuals and teams from the private sector and academic laboratories. The organizers will award a \$75,000 cash prize to the winning individual or team whose algorithm is judged to perform the best in tests using real data. Funding for the prize is provided by HHMI and the Allen Institute.

“Solving this computational bottleneck will be key for larger scale studies of brain wiring and to generate an atlas of connections in the brain,” said Allan Jones of the Allen Institute. “Sponsoring the DIADEM Challenge fits in well with the Allen Institute’s mission of providing broad enabling tools and data to the scientific community.”

Competitors will have a year to implement an algorithm for digital reconstruction of neuronal morphology and to test it against manual reconstruction, which is the current “gold standard.” Up to five finalists will compete in a final round at HHMI’s Janelia Farm Research Campus in Ashburn, Virginia, in August 2010.

The National Institutes of Health is providing partial support to a scientific conference that is independent of—but held in conjunction with—the final round of the DIADEM Challenge. Yuan Liu, program director for Computational Neuroscience and Neuroinformatics at the National Institute of Neurological Disorders and Stroke, is co-organizing the scientific conference with Ascoli and Karel Svoboda of Janelia Farm.

The idea for the DIADEM Challenge was originally discussed in 2007 at a scientific workshop at Janelia Farm. Scientists at the meeting noted that progress in understanding neural circuits was being slowed by the tedious task of tracing the structure of individual nerve cells by hand.

Even with the advent of computer technology that enables mapping in three dimensions, the full reconstruction of single neurons may take months. The vast majority of axons (the long neuronal projections that transmit information to neighboring cells) and dendrites (the branches on nerve cells that receive information from neighboring cells) must be traced manually. Researchers trace axons and dendrites that have been labeled with markers, such as green fluorescent protein, and imaged using a variety of microscopy techniques.

Participants in the DIADEM Challenge will have the opportunity to test their algorithms on the latest data supplied by neuroscientists. Thus, they will have a chance to assess their solutions in a real-world environment.

Ascoli, Liu, and Svoboda believe the DIADEM Challenge and associated conference could lead to significant scientific and technical advancements.

“It will certainly result in a critical assessment of the remaining obstacles to a complete solution,” said Svoboda. “This will be an exciting opportunity to bring computational and experimental scientists together to see if they can solve this problem.”

Full details about the DIADEM Challenge—including detailed rules and information for competitors—can be found at www.diademchallenge.org.

Allen Institute for Brain Science

Launched in 2003, the Seattle-based Allen Institute for Brain Science is an independent, 501(c)(3) nonprofit medical research organization dedicated to advancing brain research. Started with \$100 million in seed money from philanthropist Paul G. Allen, the Institute takes on projects at the leading edge of science—far-reaching projects at the intersection of biology and technology. The resulting data create publicly available resources that fuel discovery for countless other researchers worldwide. The Institute’s data and tools are available on the Web free of charge at www.alleninstitute.org.

Howard Hughes Medical Institute

The Howard Hughes Medical Institute, a nonprofit medical research organization that ranks as one of the nation's largest philanthropies, plays a powerful role in advancing biomedical research and science education in the United States. HHMI's principal mission is conducting basic biomedical research, which it carries out in collaboration with more than 60 universities, medical centers, and other research institutions throughout the United States. Approximately 350 HHMI investigators, along with a scientific staff of more than 2,000, work at these institutions in Hughes laboratories. In a complementary program at HHMI's Janelia Farm Research Campus in Loudoun County, Virginia, leading scientists are pursuing long-term, high-risk, high-reward research in a campus specially designed to bring together researchers from disparate disciplines. HHMI researchers are widely recognized for their creativity and productivity: 124 HHMI investigators are members of the National Academy of Sciences, and there are currently 13

Nobel laureates within the investigator community. The Institute also has a philanthropic grants program that emphasizes initiatives with the power to transform graduate and undergraduate education in the life sciences. To learn more about the Howard Hughes Medical Institute and the Janelia Farm Research Campus, visit www.hhmi.org.

Krasnow Institute for Advanced Study at George Mason University

The Krasnow Institute seeks to expand understanding of mind, brain, and intelligence by conducting research at the intersection of the separate fields of cognitive psychology, neurobiology, and the computer-driven study of artificial intelligence and complex adaptive systems. These separate disciplines increasingly overlap and promise progressively deeper insight into human thought processes. The Institute also examines how new insights from cognitive science research can be applied for human benefit in the areas of mental health, neurological disease, education, and computer design.

Named the number one national university to watch by U.S. News & World Report, George Mason University is an innovative, entrepreneurial institution with global distinction in a range of academic fields. Located in the heart of Northern Virginia's technology corridor near Washington, D.C., Mason prepares its students to succeed in the work force and meet the needs of the region and the world. With strong undergraduate and graduate degree programs in engineering and information technology, dance, organization psychology and health care, Mason students are routinely recognized with national and international scholarships. Mason professors conduct ground-breaking research in such areas as climate change, information technology, and the biosciences, and Mason's Center for the Arts brings world-renowned artists, musicians, and actors to its stage.

To learn more about the Krasnow Institute for Advanced Study and George Mason University, visit krasnow.gmu.edu and www.gmu.edu.

National Institutes of Health

The National Institutes of Health (NIH), a part of the U.S. Department of Health and Human Services, is the primary Federal agency for conducting and supporting medical research. Helping to lead the way toward important medical discoveries that improve people's health and save lives, NIH scientists investigate ways to prevent disease as well as the causes, treatments, and even cures for common and rare diseases. Composed of 27 Institutes and Centers, the NIH provides leadership and financial support to researchers in every state and throughout the world.

For over a century, the National Institutes of Health has played an important role in improving the health of the nation. The NIH traces its roots to 1887 with the creation of the Laboratory of Hygiene at the Marine Hospital in Staten Island, NY. The NIH is an agency of the U.S. Department of Health

and Human Services. With the headquarters in Bethesda, Maryland, the NIH has more than 18,000 employees on the main campus and at satellite sites across the country. With the support of the American people, the NIH annually invests over \$30.6 billion in medical research. More than 83 percent of the NIH's funding is awarded through almost 50,000 competitive grants to more than 325,000 researchers at over 3,000 universities, medical schools, and other research institutions in every state and around the world. About 10 percent of the NIH's budget supports projects conducted by nearly 6,000 scientists in its own laboratories, most of which are on the NIH campus in Bethesda, Maryland. To learn more about the NIH, visit www.nih.gov.