

NEUKOM|NOTES

Fall 2007

Right: Cena Miller '08 working on one of the brainbots in the Neukom Lab.



Increasingly, the study of any topic involves computation. This important field of interdisciplinary science has had a massive spurt in growth at Dartmouth, catalyzed by the creation of the Neukom Institute, endowed by the generous gift of William H. Neukom, '64.

Mr. Neukom joined Microsoft in 1985 when he became the executive vice president of law and corporate affairs. In all, he spent a total of 24 years representing Microsoft. He has been a Dartmouth Trustee since 1996, and in 2004

The Creation of the Neukom Institute

Dartmouth has been an early and an enduring world leader in the scientific fields of computation. As early as the 1940s, Dartmouth faculty and students conceived and shaped the way computer hardware and software was designed, and pioneered the broad uses of computation across the arts and sciences.

was elected chair of the Board of Trustees.

That same year, Mr. Neukom pledged the initial gift to create the Neukom Institute for Computational Science at Dartmouth. The commitment, made in honor of his family, is the largest gift in Dartmouth's history for an academic program. Part of Neukom's gift is a challenge to other supporters of the college to raise additional endowment funds that will ultimately provide the funding needed to launch a full range of Institute activities.

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COSC 53/153 and PBS 40/50.3: Introduction to Computational Neuroscience

Introduction to Computational Neuroscience was offered for the first time in Winter 2007. It began with just seven students, and grew within the first two weeks to 28 students from 7 different departments, all of whom stayed throughout the rest of the term, and reported very high ratings for the class.

The class explains the human brain from a computational perspective and students get hands-on experience running software that simulates simple brain circuitry. In the spirit of multidisciplinary computational science, we introduce concepts from neuroscience, from computer science, from genetics, evolution, engineering, and robotics. All the material is introduced from scratch: there are no prerequisites.

The course introduces the fundamental concepts of brain circuit computation including anatomical circuit design, physiological operating rules, mathematical derivations, and comparative networks.

"Lectures were amazing!"

—Course Comment by Student



Far Right: Brainbot, a robot that learns, part of the Institute's ongoing research.

A Note from the Director:

Richard Granger



Right:
Professor
Granger with
some of the Insti-
tute's
brainbots.

Since arriving at Dartmouth a year ago, it's been a time of terrific excitement and growth at the Neukom Institute. Computational Science is the study of the hidden rules underlying complex phenomena, throughout the spectrum of arts and sciences. The Institute focuses on computational analyses of primarily biological and psychological phenomena: How do our brains store and retrieve memories? How do genes build organs and bodies? What mental steps occur in everyday decision-making? How did the human brain evolve from previous hominid brains?

Research

Once we can computationally understand a natural phenomenon, we can attempt to simulate it artificially. Thus we use our analyses of the brain to build brain simulations, which are currently being used in the Institute laboratories to operate brain-based robots, or "brainbots." We're also running software simulations of language learning, visual recognition, and early developmental learning.

There are many opportunities for undergraduate research on these projects and others. Last year a team entered the "Google Build Your Campus In 3-D" competition. Ten undergraduates, directed by Lorie Loeb and sponsored by the Neukom Institute, built a complete 3D model of the entire Dartmouth campus and won the national competition! Their model can be viewed by launching Google Earth and navigating your way to Hanover.

Undergraduates

Three of our undergraduate interns deserve special mention: Stephanie Gagnon'10

has been awarded a Howard Hughes Medical Institute Fellowship; Marissa Alert '08 has been elected a Presidential Scholar; and Travis Green '08 has been elected Student Assembly president. Congratulations to all! Many other undergraduates have done great work in the Institute, including six participants in WISP (the Women In Science Program), who presented posters at the Undergraduate Research Symposium in May.

A number of undergraduates have worked with us to build their own undergraduate majors, centered on various topics in computational science, including: Computation and Intelligence, Computation and Evolution, Computation and Music, Computation and Robotics.

New Additions

The latest member of the Neukom Institute is our new Institute Manager, Victoria Smith. Victoria is the former CEO of TV production company Ocean Communications, was the producer and host of PCTV and MacTV, has been a regular feature writer for several magazines, and was Manager of the Office of Multicultural Affairs at Dartmouth Medical School. She is an inspiring presence, and we're all excited to be working with her.

I look forward to working with students across the campus in the Institute laboratories, and I look forward to meeting new undergraduates and talking with them about their interests. We hope this year is as eventful and productive as the past year, and we're looking forward to the many invited talks, symposia, classes, and laboratory projects that are already under way.

--Richard Granger

Doing What He Wants Creating His Own Major Using Neukom:

TRAVIS GREEN '08

Through the Neukom Institute, Travis Green '08, the 2007-2008 Student Assembly President, has been able to create his own major using three areas of interest to him: computer science, neuroscience, and genetics. "The goal is to understand the genetic factors that enable the brain to be constructed, and to attempt to replicated them in order to pre-train our learning algorithms," Green said. "Without the Neukom Institute, I wouldn't be able to even scratch the surface of my goals." The final title of his major is Natural and Artificial Intelligence.

Besides being president of the student assembly, Green is also a member of Dartmouth's heavy-weight crew team and a brother at Sigma Phi Epsilon fraternity. Green has somehow also found time to get very involved with the Neukom Institute and is very happy with the opportunities it has given him to create a major perfectly crafted to his interests. "No other opportunities exist on this campus to do this



"No other opportunities exist on this campus to do this sort of work."

--Travis Green '08

Left: Travis Green '08

sort of work," Green said. "I'm already researching in the lab and Professor Granger [Green's faculty advisor] is a fantastic trove of information."

Artificial intelligence has always been an interest of Green's, but he noted that he has never been satisfied with current approaches, which is why he plans on entering the field of neuroscience, or the currently nonexistent field of neurogenetics. After he finishes his time at Dart-

mouth, Green plans on going on to graduate school and applying for graduate fellowships in the field of artificial intelligence. As for his long-term goals with his major, Green said that he'd like to see computers begin to have learning capabilities. "I don't want to see sentience," Green said, "but a computer that could understand that when I accidentally close my final paper and then frantically try to recover it, it shouldn't hide [my paper] somewhere deep down in the temporary files folder."

Using Neukom as a First-Year Student: WISP Intern

STEPHANIE GAGNON '10



Above: Stephanie Gagnon '10

Steph Gagnon '10 first heard about the Neukom Institute when she interviewed for a Women in Science Program (WISP) internship with Professor Granger. Gagnon learned about WISP internships before she'd even started her first term at Dartmouth -- as a member of the sailing team, she was training during the pre-season when she talked to a senior who had taken her WISP internship and made it her senior thesis. Gagnon became interested and applied for several different internships through WISP.

"I had never really heard of computational neuroscience, or brain circuit computation," Gagnon said, but once she interviewed for the position with Professor Granger, "the experiments and projects he talked about sounded really interesting."

Gagnon took the internship, as well as the Intro to Computational Neuroscience course Winter term, and described her experience as "amazing."

"It combined math and computer science with neuroscience, which I find really cool," Gagnon said. "It's a really new field, and with new advances in technology, the opportunities and possibilities of where it will go seem endless."

Besides being a member of Dartmouth's sailing team and an intern with the Neukom Institute, Gagnon also finds time to be part of Big Green Readers, and to volunteer her time with the local Special Olympics.

The Neukom Institute Wins IBM's Cell University Challenge

A team of researchers led by the Neukom Institute and collaborating with the parallel systems group at the University of California Irvine, took first place in IBM's first annual Cell Broadband Engine™ (Cell/B.E.) Processor University Challenge. Nearly 80,000 students from 25 countries competed to invent their own applications using this powerful processor, the Cell/B.E., originally designed by IBM, Sony Group and Toshiba Corp., for use in consumer devices such as Sony Computer Entertainment's Playstation 3.

Student Ashok Chandrashekar and research assistant professor Andrew Felch from the Neukom Institute, along with Jayram Moorkanikara Nageswaran and Jeff Furlong from the University of California, Irvine, won the competition by porting a vision algorithm to three Sony Playstation 3s whose parallel processor architecture decreased the usual processing delay from 2-3 minutes to one second. "A one-second delay is essentially real time recognition and that is just what humans do," Felch said.

The teams with winning designs were each presented a cash prize ranging from \$2,500 to \$10,000 for their work.



Right Top:
Andrew Felch, Research Assistant Professor and Lab Manager

Right Bottom:
Ashok Chandrashekar MS '08 working in the Neukom lab.

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