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News

Tech Team Supercharges Agent-Based Modeling with Video-Game Technology
by Marcia Goodrich, senior writer

An unlikely team of Michigan Tech researchers is harnessing the computing muscle behind the most popular video games to understand the most intricate of real-life systems.

Led by Roshan D'Souza, an assistant professor of mechanical engineering–engineering mechanics, the group has devised a way to supercharge agent-based modeling, a powerful but computationally massive forecasting technique. In particular, they are focusing on computer models of complex biological systems.

Their breakthrough transforms an off-the-shelf desktop PC into a supercomputer by using graphic processing units (GPUs), which drive the spectacular 3-D imagery of video games.

GPUs have evolved into powerful processors capable of billions of color calculations every second.

Agent-based modeling simulates the behaviors of complex systems. It can be used to predict the outcomes of anything from pandemics to the price of pork bellies. It is, as the name suggests, based on agents: e.g., sick people and well people, bullish and bearish investors, predators and prey, etc. It applies rules that govern how those agents behave under various conditions, sets them loose, and tracks how the system changes over time. The outcomes are unpredictable and can be as surprising as real life.

Agent-based modeling has been around since the 1950s, but the process has always been handicapped by a shortage of computing power. Until recently, the only way to run large models quickly was on multi-million-dollar supercomputers, such as IBM's Blue Gene.

In a closet-sized lab in the MEEM, however, all that is changing. Under the direction of D'Souza, a team of Michigan Tech computer science students has been programming GPUs to run models with tens of millions of agents—and to do it with blazing speed.

"With a $1,400 desktop, we can beat a computing cluster," says D'Souza. "We are effectively democratizing supercomputing and putting these powerful tools into the hands of any researcher who desires them. Every time I present this research, I make it a point to thank the millions of video gamers who have inadvertently made this research possible."

Computer science senior Mikola Lysenko demonstrates on his computer, running a model of the human immune response to a tuberculosis bacterium. On the monitor, a swarm of bright green immune cells surrounds and eventually contains a yellow TB germ. These busy specks look like 3D-animations from a PBS documentary, but they are actually virtual T-cells and macrophages—the visual reflection of millions of real-time calculations.

"I've been asked if we ran this on a supercomputer or if it's a movie," says D'Souza. In fact, their model is several orders of magnitude faster than state-of-the art agent modeling toolkits. According to the researchers, however, their current effort is small potatoes.

"We can do it much bigger," says D'Souza. "This is nowhere near as complex as real life." Next, he aims to model how an infection could spread from the lung to the patient's lymphatic system, blood and vital organs.

Dr. Denise Kirschner, of the University of Michigan in Ann Arbor, developed the TB model and gave it to D'Souza's team, which programmed it into a graphic processing unit. Agent-based modeling hasn't replaced test tubes, but it is providing a powerful new tool for medical research.

"Our raison d'etre is this," Kirschner explains. "A lot of scientists look at the immune response to TB in Petri dishes or in monkeys. We build a computer model to test a hypothesis."

Computers offer significant advantages. "You can create a mouse that's missing a gene and see how important that gene is," she says. "Using agent-based modeling, we can knock out two or three genes at once." In particular, agent-based modeling allows researchers to do something other methodologies can't: virtually test the human response to serious insults, such as injury and infection.

While agent-based modeling may never replace the laboratory entirely, it could reduce the number of dead-end experiments. "It really helps scientists focus their thinking," Kirschner said. "We can recapitulate what the scientists are doing and then address questions they can't ask."

By programming GPUs, D'Souza's team is helping to overcome the field's primary stumbling block, she said. "The limiting factor has been that these models take a long time to run, and his method works very quickly and efficiently," she said.

"It has a lot of potential," she added. "I hope he can get some funding and do more work on it, because this area is becoming so hot—it's just blooming."

Dr. Gary An, a surgeon specializing in trauma and critical care in Northwestern University's Feinberg School of Medicine, is a pioneer in the use of agent-based modeling to understand another matter of life and death: sepsis. Virulent microorganisms sometimes spread from an infection site and provoke massive, fatal inflammation. But with billions of agents, including a variety of cells and bacteria, sepsis has been too complex to model economically on a large scale, at least until now.

"The GPU technology may make this possible," said An. "This is very interesting stuff, and I'm excited about it."

The Tech team also looks forward to applying their model in other ways. "We can do very complex ecosystems right now," said team member Ryan Richards, a computer science senior. "If you're looking at epidemiology, we could easily simulate an epidemic in the US, Canada and Mexico," Richards said.

Mechanical engineer D'Souza recruited his team of computer-savvy wunderkinder when he was investigating realtime techniques to determine if parts designed on a computer could actually be manufactured in real life.

Because the research is computer science—intensive, he approached Lysenko, Richards and senior Nick Smolinske. The trio has since competed in the ACM International Collegiate Programming Contest, known as the Battle of the Brains, where they finished 47th in a field of the top 100 college computer-programming teams in the world and tied for sixth among the US teams.

The team stumbled across agent-based modeling when D'Souza came upon a research paper that described an agent-based model of a bacteria colony. When the team tried to replicate the results on existing software systems, they found that any model having more than a few thousand agents took an inordinately large amount of time to compute. Lysenko had the idea to use video cards to speed up these computations and figured out

how to program them for the task.

"GPUs are very difficult to program. It is completely different from regular programming," said D'Souza, who deflects credit to the students. "All of this work was done by CS undergrads, and they are all from Michigan Tech. I've had phenomenal success with these guys—you can't put a price tag on it."

In particular, he recognizes Lysenko's contribution. "Without Mik, this wouldn't be possible," D'Souza said. " It's been a pleasure working with him for the last two years."

Have You Received a FOIA Request? Here's What to Do
Michigan Tech is a public institution and, as such, many of its records are open for public inspection under the Michigan Freedom of Information Act.

To submit a request for information, anyone may contact the University's Staff Associate to the President Roberta Dessellier, the University's freedom of information officer. Dessellier reviews the request and determines if the information can be released; she is required by law to respond within five business days.

While the University tries to be as open as possible regarding its records, some documents, including student records and personnel files, are privileged. If you receive a formal FOIA request, forward it to Dessellier in the Office of the President. Likewise, contact her at 487-2200 or roberta@mtu.edu if you have any questions regarding what information may be legally released.

A summary of the Michigan Freedom of Information Act is available here or from the state Office of the Attorney General website, www.michigan.gov/ag : click on "Consumer Protection" and then "FOIA/OMA."

UAW Approves Contract
UAW Local 5000 has ratified a one-year, full contract with Michigan Tech. Approved on a 95-13 ballot, the terms of the agreement include a 3-percent pay increase for the represented office professionals at the University.

The contract also includes a 1-percent equity component that recognizes the growing level of professionalism within the union membership and aims to partially address compensation imbalances between UAW employees and other staff at the University. The high standard of customer service and the computing and business skills brought to these positions contribute substantially to the mission of the University, said Director of Labor Bill McKilligan.

The new contract includes a clause stipulating that if the University provides additional paid time off for nonunion employees, UAW employees will receive the same time off with pay.

"The UAW leadership really does look at all the angles on an issue," McKilligan said. "Their emphasis on professionalism and equity benefits not only their membership, but also the University as a whole."

"We appreciate that the University recognizes our professionalism and our loyalty to Michigan Tech," said Barbara Ruotsala, president of UAW Local 5000. "The UAW membership continues to value the students as our customers and to meet their needs with care and respect."

Voter Registration on Campus Today
Not yet registered to vote in November's presidential election? Michigan residents can seize the opportunity to

register right here on campus. A voter registration drive, geared toward students but open to all of the campus community, will be held today, Wednesday, Sept. 3, 11 a.m.-2 p.m. in front of the Memorial Union.

In just a few minutes you can register for the 2008 election. Registering at school is the easiest way for students, and in Michigan, if it's your first time voting, you have to register in person. Bring your Michigan driver's license.

Fall Athletics Luncheon Thursday
by Wes Frahm, director of athletic communications and marketing

The first of three Michigan Tech athletics fall luncheons will be held Thursday, Sept. 4, at noon in the Begg Conference Room of the Peter J. Grant Hockey Educational Center.

Head football coach Tom Kearly will be the featured speaker at all three luncheons. Cross country coach Joe Haggenmiller will also be on hand at Thursday's event.

Volleyball coach Krista Mikesch and tennis coach Mike Axford will be guest speakers at the next two luncheons, which are scheduled for Thursday, Sept. 11, and Thursday, Oct. 2.

Fall luncheons are free and open to the public. A complimentary light lunch will be served.

TIAA-CREF to Hold Counseling Sessions, Retirement Seminars Next Week
TIAA-CREF will be on campus Sept. 9-11 for individual financial counseling sessions in Memorial Union Ballrooms 1 and 2.

This is available to all Michigan Tech employees and retirees.

To schedule a counseling session, visit www.tiaa-cref.org/moc or call Linda Baker at 1-800-842-2044, extension 1412.

TIAA-CREF will also present two retirement seminars next week in Memorial Union Ballroom 3. The first session will be held Tuesday, Sept. 9, 11 a.m.-noon, and a repeat session will be held on Wednesday, Sept. 10, 4-5 p.m.

Entertainment and Enrichment

IBM Exec to Give Two Talks for Students Thursday: "Banker to the Poor," "Your Future at Michigan Tech"
Michigan Tech alumnus John Soyring, IBM's vice president for solutions and software, will give two talks on campus for students Thursday, Sept. 4.

His first, "Banker to the Poor: Computer Science and Social Responsibility," will be held at 3 p.m. in Dow 641 for business management and introductory computer science students.

His second, the inaugural presentation of the First Year Engineering Lecture Series, is "Your Future: Michigan Tech and Beyond," at 6 p.m. in the Rozsa Center.

Both talks are free and open to the public; seating is limited.

In his evening talk, Soyring will discuss how to identify innovation that really matters to business and society

and how to develop the core competencies needed to be a top contributor, both as a student and in the business world.

In "Banker to the Poor," he will touch on micro-lending, including the work Muhammed Yunus and the Grameen Foundation to fight poverty through very small loans that enable the poor to start businesses. Soyring guides IBM's support of the project in line with the company's investment strategy "Innovation that Matters—For Our Company and for the World."

Soyring joined IBM in 1976 after graduating from Michigan Tech with a BS in Electrical Engineering. In his current position, Soyring provides global business leadership for a multi-billion-dollar portion of the IBM software business. He has received an honorary doctorate in engineering from Michigan Tech and is a member of the University's National Campaign Committee, a group of 10 select alumni and friends who are steering and advising the current fundraising campaign.

Seminars and Workshops

MSE Seminar Friday

Alex O. Aning, of the Department of Materials Science and Engineering at Virginia Polytechnic Institute and State University, will present "Processing and Properties of Amorphous Reinforced Crystalline Matrix Composites in Ni-W Alloy System" on Friday, Sept. 5, 3-4 p.m. in M & M 610 as part of the John and Virginia Towers Distinguished Lecture Series.

For more information or an abstract, contact Margaret Rothenberger at mproth@mtu.edu .

Regular Features

In Print

Professor Jennifer Daryl Slack (Humanities) published "Resisting Ecocultural Studies" in Cultural Studies, volume 22, issues 3-4, May 2008.

Sports in Brief

What's Happening This Week in Athletics

All times are Eastern, and home events are italicized.

Wednesday, Sept. 3
Huskies Drive Time, 7:30-8 a.m., live on 93.5 FM

Friday, Sept. 5
Volleyball at Lewis Flyer Invitational (Romeoville, Ill.)
• vs. Winona State, 11 a.m.
• at Lewis, 3:30 p.m.
Cross Country at Pre-GLIAC Meet (Sault Ste. Marie), 4 p.m.

Saturday, Sept. 6
Volleyball at Lewis Flyer Invitational (Romeoville, Ill.)
• vs. Wisconsin-Parkside, 11 a.m.
• vs. Indianapolis, 5:30 p.m.
Football hosts Hillsdale, 1 p.m., live on Mix 93.5 FM

Last Week's Results

Football (1-0, 0-0 GLIAC)
• Aug. 30—at Michigan Tech 26, No. 25 Winona State 21

Volleyball (3-1, 0-0 GLIAC)
All matches at Nebraska-Omaha Invitational
• Aug. 29—Michigan Tech 3, Mary 0 (25-14, 25-16, 25-11)
• Aug. 29—Michigan Tech 3, Northwest Missouri 1 (25-20, 22-25, 25-22, 25-22)
• Aug. 30—Minnesota State Moorhead 3, Michigan Tech 2 (25-18, 23-25, 17-25, 25-22, 15-12)
• Aug. 30—Michigan Tech 3, No. 11 Emporia State 1 (25-17, 23-25, 25-10, 25-19)

Cross Country
• Aug. 29—Women 2nd of three teams; Men 2nd of five teams at UP Collegiate Opener (Houghton)

Top News of the Week

Short Sets Another School Record Vs. Winona
Quarterback Steve Short completed a school-record 24-of-28 passes (85.7 percent) in a 26-21 season-opening win vs. Winona State Saturday, Aug. 30. The junior now has four school records—all of which he set vs. Winona State. He broke the records for passing yards (431), passing touchdowns (six) and total offensive yards (504) at Winona in last year's season opener.

Huskies Top No. 11 Emporia State; Go 3-1 in Opening Weekend
The Michigan Tech volleyball team posted a 3-1 record at the Comfort Inn & Suites/Firewater Grille Tournament hosted by Nebraska-Omaha Friday and Saturday, Aug. 29-30. The Huskies registered a school record 20.0 blocks in a 3-1 win over No. 11 Emporia State Saturday. Seniors Veronica Armstrong and Jen Jung each finished the weekend with a team-high 52 kills. Jung also recorded 26 blocks in the four matches.

Cross Country Opens at Home
Sophomore Brian Stetter was the Huskies top finisher and second overall at the UP Collegiate Opener hosted by Michigan Tech Friday, Aug. 29. Stetter finished the five-kilometer course in 16:25.9. Senior Laura Kangas finished fifth to lead the women's team in a time of 20:36.7. The men's team finished second out of three teams, and the women's team finished second out of five teams.

In the News
Honolulu's Star Bulletin featured the research of adjunct faculty members Adam Durant and Matt Watson (GMES) in "Balloons Take to Sky for Volcanic Gas Study," by Helen Altonn.

Click here to read about measuring volcanic gases from Kilauea Volcano and the findings, which "show that sulfur dioxide gas eventually forms airborne droplets of sulfuric acid that are even more harmful to lungs than the original gas."

The Chicago Tribune also picked up the story as distributed by the Associated Press; read it here.

New Funding
Assistant Professor Michael Bowler (Humanities) has received $299,614 from NSF for a three-year project,

"Responsible Conduct of Research in Science and Engineering Education: Moral Motivation and Ethical Sensitivity in Multi-National Graduate Students."

On the Road

Associate Professor Mary Durfee (Social Sciences) was discussant for the panel Courts and the Politics of International Human Rights Protection and chair of the panel Framing the Global Village in the Political Science Classroom at the annual meeting of the American Political Science Association, held Aug. 28-31 in Boston. She also participated in the association's ongoing mentoring effort.