EZRA
CORNELL UNIVERSITY'S MAGAZINE EXTRA

This special section, a bonus issue of the university's Ezra magazine, highlights ways Cornell initiatives intersect with philanthropy and engagement of Cornell alumni, parents and friends.

Robert Barker/ University Photography

COLLABORATION ACROSS (BASEBALL) FIELDS LEADS TO AMAZONIAN RIVERS

By Matt Hayes

An ambitious project that deploys big data and uses machine learning to understand the ecological impacts of hydropower dams in the Amazon Basin started in a mundane enough setting: on the sidelines at youth baseball games. Conversations initially sparked when they were parents at local games ultimately led ***Alex Flecker****, professor of ecology and evolutionary biology in the College of Agriculture and Life Sciences, and* ***Carla Gomes****, professor of computer science and director of the Institute for Computational Sustainability, to a collaborative effort to solve problems facing one of the most biodiverse areas of the world. Using a seed grant from the Atkinson Center*

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Christianne White

"AS A COMPUTER SCIENTIST, I KNOW OUR LIMITATIONS. WE KNOW VERY LITTLE ABOUT ECOLOGY, HYDROLOGY, AND SO IT'S KEY THAT WE TEAM UP WITH THE RIGHT EXPERTS."

for a Sustainable Future and additional support from the National Science Foundation's Expeditions in Computing initiative, the researchers are collaborating across disciplines as they evaluate the cumulative economic and environmental impacts of dams. The full conversation is available at ***www.news.cornell.edu/FleckerGomes****.*

Your areas of expertise seem, on the surface, to be far apart. How did this collaboration take shape?

Flecker: It all comes back to baseball. Ten years ago, we both had kids who played baseball together. We would sit on the sidelines and talk about how it would be great to do something together. I'm an ecologist, and a lot of the work that I do involves tropical rivers in South America. For the past six years, I've been working on a project exploring vulnerabilities of species to climate change, and spending a lot of time in the Andes and Amazon regions, especially Ecuador.

It's been striking to see how many hydropower sites are in different stages of development. You look on a map, and there are literally hundreds of dots with proposed sites for dams in the Amazon region. But these are also places in which there is very, very little on-the-ground data available. So what we started thinking, with all of these dots on the map, [was] some of these have to be better locations than others. And that's where Carla has been pivotal.

Gomes: I'm a computer scientist, and I'm passionate about using the advancement of computer science to really impact the world. Computer science is permeating all kinds of disciplines and is transforming the way our society functions, including in areas of business, on Wall Street. So why not use computational thinking to solve challenges in sustainability? With the Institute for Computational Sustainability, we are trying to have impact and think of nature in the same way major companies are using computer-science tools to optimize their own enterprises.

Dealing with something as big and complex as the Amazon, where do you begin?

Flecker: Dams are usually planned project by project in terms of local impact rather than in some integrated fashion. If you plan dam by dam, you're always going to get suboptimal solutions. So that's what we started thinking about. My work centers on what are called ecosystems services. These are the benefits ecosystems provide that people really care about. In the Amazon, biodiversity and river fisheries are hugely important in people's lives. So understanding connectivity – the length of free-flowing rivers – is important for things like fish migrations.

Another ecosystem service is navigable rivers. Other aspects, like nutrient cycling and sediment flows, are incredibly important for the way that the rivers structure floodplains. How and where dams are constructed are huge questions that impact ecosystem services, but the Amazon is a region where not much data exists, if at all.

Gomes: Our role has been to think about how to articulate the problem we want to solve and then model it. For example, start with a very basic tradeoff: having dams producing electricity is a positive, but that is going to negatively impact connectivity along the river. But how do we understand that problem in the absence of a lot of specific information? Can we use big data, for example from remote sensing, to infer valuable information for the Amazon Basin?

Flecker: We want to see if we can at least estimate some of these things within these different projects. To do this right is computationally complex. Carla and her group are thinking about sustainability issues that require a lot of computing power.

Gomes: Computer science has developed tools and models to design big computer networks, to design the grid. When you look at river connectivity, we leverage those

'The challenge is how to transform the vast amounts of remote sensing data from Landsat and other sources into meaningful information concerning ecosystem services.'

– Carla Gomes

'To do this right is computationally complex. Carla and her group are thinking about sustainability issues that require a lot of computing power.'

– Alex Flecker

advances to reflect the reality of the Amazon. We found an example of a set of dams that disrupts major connectivity, but their placement does not contribute much globally in terms of electricity generation.

What have you learned from each other?

Gomes: As a computer scientist, I know our limitations. We know very little about ecology, hydrology, and so it's key that we team up with the right experts. Alex has been incredible sharing his own expertise and bringing together all kinds of expertise. It's really awesome.

Flecker: One thing you learn from Carla is, don't be afraid of thinking of problems that, in our group, would have been impossible to work through due to the huge amount of raw data. With Carla, we can combine vast quantities of unprocessed data from many different sources, including global data collection systems, that are valuable for addressing complex sustainability problems. It's been incredibly inspiring.

We have a group of four to five faculty, grad students and postdocs, and every Friday afternoon we hold conversations as a group that go for hours.

Gomes: We have ways to approach these problems on a large scale. When we first started, we began thinking about only one region, and then I said, 'Why not go to the entire Amazon?'

Flecker: That's the perfect example. To me, focusing on one region of the Amazon seemed computationally difficult enough. Yet, when they did their first analysis, they ran it in a tenth of a second.

Gomes: "A little bit of knowledge can be dangerous." That's a saying, right? I'm Portuguese, and for a non-native speaker, getting the idioms right is the toughest. Often people know these problems are computationally hard, so they say, "We don't know what to do. These problems are too hard."

Our approach to global optimization and modeling of environmental challenges is similar to the way companies such as Amazon use computational models to obtain near-perfect efficiency of the full supply chain. It's quite remarkable, with a little computational thinking and computational power, how we can now find the optimal solution in about 10 minutes. With Alex, I said, going to the entire Amazon Basin, I think we can do it. That's what excites me: the scale. I say let's go big. We are going big; I love that (laughs).

Alex, how has Carla's approach changed what you do?

Flecker: It has changed, in dramatic fashion, the whole scale in which we work. It opens us up to think much differently in spatial scales, and temporal scales as well. Exposure to computational sustainability has revealed for me, dramatically, the power of machine learning and the optimization possibilities.

Gomes: We are using computational methods – in particular, machine learning – to infer information from remote sensing. For example, Landsat is a satellite that has been orbiting Earth for over 40 years. The challenge is how to transform the vast amounts of remote sensing data from Landsat and other sources into meaningful information concerning ecosystem services such as river connectivity, nutrient and sediment flows, and fish habitat, to incorporate into our decision-making models.

These problems are fascinating and truly challenging. Moreover, by studying these real-world problems, we are also advancing computer science. The sustainability challenges force us to develop new computational methods that can then also be applied to other domains. … Computational sustainability is a wonderful domain for computer scientists to have a significant positive impact in the world.

Flecker: The reason for doing this is to have an impact. We think we can contribute and say: These are tradeoffs, and there are other, better places to do this, and here's where they are. This is a long-term process, but we know we can have an impact.

Matt Hayes is managing editor and social media officer for the College of Agriculture and Life Sciences.

Opposite page: Professor Carla Gomes draws nodes and edges of a graph representing real-world networks in the Computational Sustainability Lab in Gates Hall.
Below: Professor Alex Flecker looks down on Cascada de San Rafael, the largest waterfall in Ecuador, which is just downstream from a mega-hydropower project that is being installed.

Provided

Highlights from Ezra magazine and Ezra Update:

From one generation to the next: The endowed scholarship challenge

Silja Magg

Provided

Edward Estrada/Provided

Cornellians of all stripes are coming together to meet the challenge of boosting financial aid through their support of a new endowed scholarship challenge.

Launched in December 2016, the challenge is approaching the halfway mark of its goal of raising an estimated $25 million in endowed scholarships, essential to upholding Cornell University as “an institution where any person can find instruction in any study.”

To date, 41 donors have given a combined $9.8 million. To increase their impact, the university is matching these gifts of $200,000 or more (payable within five years) on a 1-to-4 basis, thanks to a $5 million unrestricted bequest by Craig Voorhees ’49, who was a benefactor of scholarships in his lifetime. Already, $2.45 million in matching funds have been awarded.

Ranging from the Class of ’44 to the Class of ’02 and representing alumni as well as family members and friends, these early supporters are showing how Cornellians can shape the destinies of future generations.

Learn how you can help pave the way for Cornellians to come.

Contact:
Allison D. Riley ’84
Project Manager for the Endowed Scholarship Challenge
Division of Alumni Affairs and Development, Cornell University
130 East Seneca Street, Suite 400
Ithaca, NY 14850
abd1@cornell.edu
607-254-7158

Above: Richard Meier ’56, B.Arch. ’57, made an endowed scholarship gift to benefit graduate architecture students at the College of Architecture, Art and Planning. **Left, top:** An unrestricted bequest from Craig Voorhees ’49 provided $5 million in matching funds for the endowed scholarship challenge. During his lifetime, Voorhees had also established a scholarship. **Left, bottom:** As a tribute, Edward Estrada ’94 named his endowed scholarship after his father, Robert K. Estrada (seen on the right). The scholarship benefits first-generation students at the College of Arts and Sciences.

“The day my father and my mother dropped me off at Cornell, they knew it was such a huge step. They knew the lifelong impact it would have and that it would also provide opportunities to my own children that they did not have.”

– Edward Estrada ’94

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