Searching *for* Words

What's at stake when languages are lost?

By Karen McCally '02 (PhD)

It's Friday afternoon, and Farai Mutonhori '19 arrives at the crowded entrance to the Wilson Commons Starbucks. Dressed in a white Oxford shirt and tie, the freshman electrical and computer engineering major from Masvingo, Zimbabwe, is taking time out from his usual routine of classes, workshops, and labs to talk about what some of his American friends consider to be one of his more unusual aptitudes. Mutonhori speaks five languages in addition to English. "I speak Zulu, Sotho, Ndebele, Shona, and a little bit of Venda," he says.

As exotic as such multilingualism might appear in many contexts, in Mutonhori's native region, it's how things are. "It's typical. People in Zimbabwe don't speak one language," he says. "There was a point where—it was very strange for me growing up as a kid. I would use, maybe, three languages in a sentence at some point. But as you go along, you get used to all of them, and you become fluent."

Mutonhori's first language is Ndebele. Ndebele is not, according to the definition accepted widely among linguists, an endangered language. But Mutonhori feels its position is precarious. When he was growing up, Zimbabwe was embroiled in civil war, and his Ndebele community fell under the domination of Shona-speaking ethnic rivals. His father responded by adopting a Shona surname. Although Ndebele remains, along with Shona and English, an official language of Zimbabwe, Shona domination continues. "Our president is Shona. In politics, Shonas make more of the decisions," Mutonhori says.

There are regions of the globe, including much of sub-Saharan Africa, in which so many languages live within such a small geographic area that people there, like Mutonhori, may engage in conversations in multiple languages within a single day, depending on the people with whom they're speaking. For linguists, such regions are laboratories for the study of the human capacity to absorb language and to shape and reshape it collectively over time.

But linguists worry there will be fewer such places in the future. The fate Mutonhori fears for Ndebele is a present reality for many languages around the globe. There are slightly more than 7,000 distinct languages in use in the world today, according to the *Ethnologue,* a definitive source of information about languages around the world researched and compiled by the Dallas, Texas, based organization SIL International. They come in

THE MULTILINGUAL NORM: Farai Mutonhori '19 came of age fluent in five languages, and conversant in a sixth. Multilingualism on that scale is still the norm in parts of the world such as his native Zimbabwe. But linguists wonder how long that will be the case.

striking varieties, spanning more than 140 language families, and including well over 100 deaf sign languages.

"We have an enormous world of variability out there," says Joyce McDonough, a professor of linguistics and brain and cognitive sciences at Rochester. "When I look at a language, I am always astounded at the way they're put together. They're remarkable. They're beautiful. And they're disappearing."

The *Ethnologue* groups languages on the basis of 12 categories of language status, from thriving, national languages to languages that no longer have any known speakers. Estimates among linguists range considerably, but the most conservative estimates predict that by the end of this century, half of the languages now in use will have vanished.

The prospect of widespread language loss confronts scholars with an irony. Humanity may have more access to education, more sophisticated tools for learning, and more cross-cultural contact than ever before. But at the same time, greater mobility and cross-cultural contact can place the spectacular range of human thought and invention at risk.

McDonough, who has taught at Rochester since 1997, specializes in North American languages, in particular, Navajo and the related Athabaskan or Dene languages. She's been working for several years on a study of the remote Dene-speaking communities in the Mackenzie River Basin of northwestern Canada. When a language disappears, she says, a culture disappears with it, as does knowledge that the community has built up over centuries. When a language is lost, entire oral traditions of storytelling can be lost with it. Highly specialized knowledge of local plant and animal life—knowledge built up over many years and held exclusively, in many cases, within endangered language communities—also vanishes.

CRACKING THE LINGUISTIC CODE: Nadine Grimm (top), a specialist in Bantu languages who has conducted field research most recently in Cameroon, oversees a new program in language documentation. Joyce McDonough (bottom), a scholar with a long track record of work with the Navajo and the Dene language communities in northwestern Canada, was instrumental in the program's formation.

There's an additional problem that weighs heavily on scholars of language. To illustrate, McDonough draws an analogy between language and plants. "Imagine if we only had access to a few different types of plants and we had to describe the phenomena of plant life on the basis of that," she says. "With the enormous amount of variability out there, we would be missing a lot." Yet linguistic research has been based disproportionately on Indo-European languages. "The assumptions we make about what can and cannot be part of language or expressed by language are constantly confounded by new discoveries in under-resourced languages," she and a coauthor wrote in an article in the *Annual Review of Linguistics* in 2015.

That's a point echoed by scholars whose work is not directly related to language documentation, but relies on it nonetheless. Florian Jaeger, an associate professor of brain and cognitive sciences, of linguistics, and of computer science at Rochester, develops computational models of human language processing. The integrity of his research, and that of colleagues who develop similar models of language acquisition, rests on the availability of diverse data sets.

"We can think of our brain as a filter," says Jaeger, whose current research draws on Yucatec Maya, one of approximately 70 Mayan languages spoken in southern Mexico and Central America today. "You could come up with some linguistic innovation right now, but if I can't make sense out of it, it's not going to survive. So what is the structure of that filter? We will only figure that out if we have a good idea of the variability that's actually out there."

In 1991, recognizing the pace of language loss, the Linguistic Society of America issued a call to action at a symposium titled "Endangered Languages and their Preservation." The type of language loss occurring in the modern era, participants argued, was not to be confused with the evolution of language that has taken place among virtually all languages throughout human history. Evolution involves the merging of features of multiple
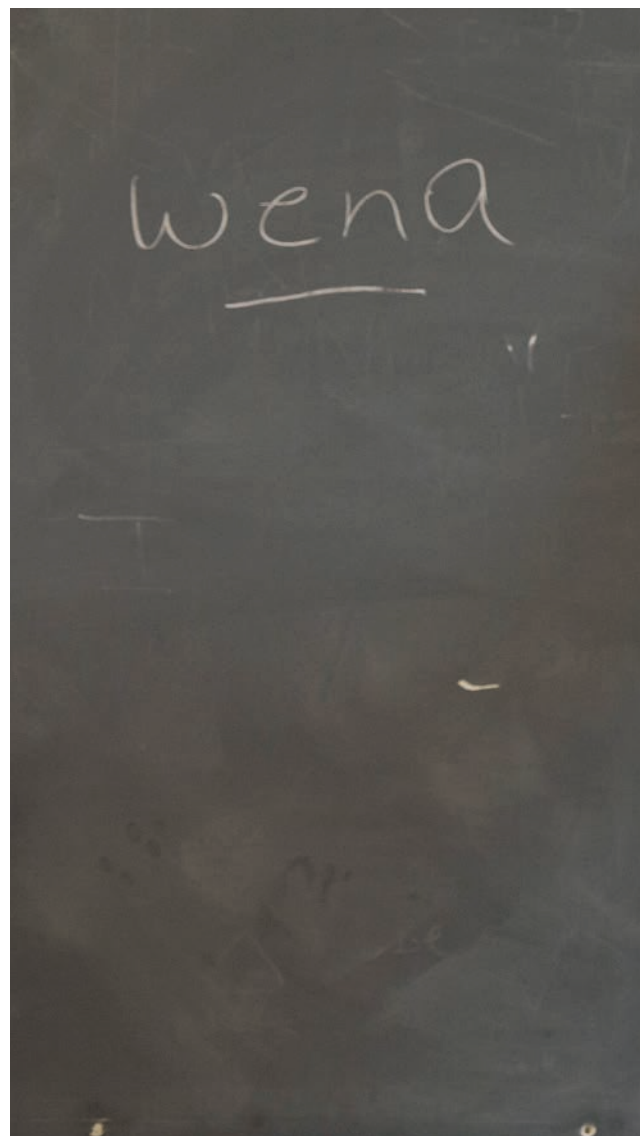
languages, usually within particular geographic areas, and at a relatively slow pace; in modern times, given much greater human mobility, language communities have been overwhelmed and subsumed by their more powerful counterparts with unprecedented speed.

For the past several years, faculty in Rochester's linguistics department have responded, offering seminars to train students to work with endangered and understudied languages. Beginning this fall, the department will ramp up its efforts with a new master's degree program specifically in language documentation.

The program will be overseen by Nadine Grimm, a specialist in African languages, particularly those in the Bantu family, who joined Rochester's linguistics department last year.
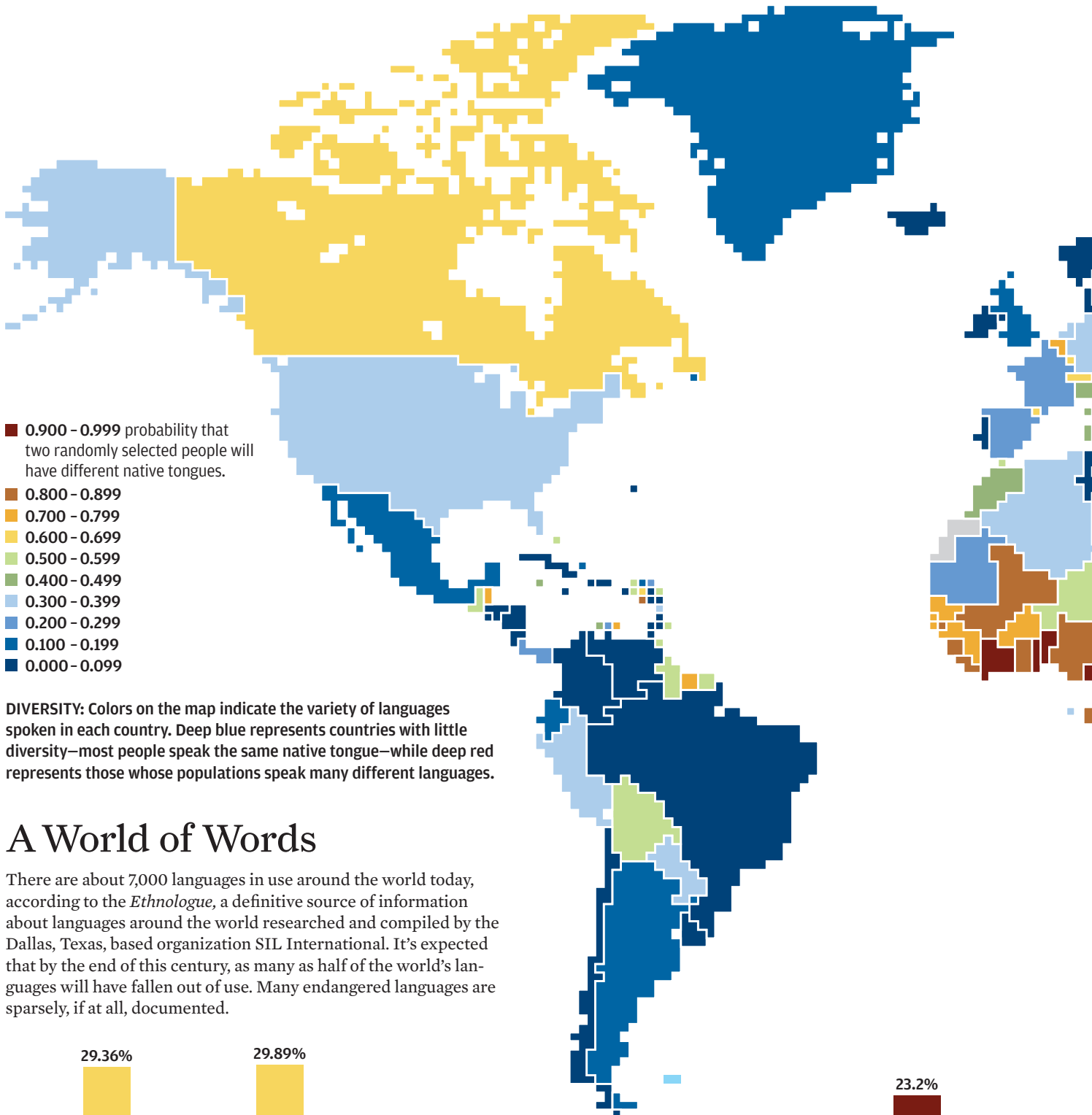
Last fall, Grimm reached out to Mutonhori, looking for native speakers of languages that would be completely unfamiliar to the students registered for her spring seminar, Field Methods in Linguistic Description. She offered Mutonhori a job as linguistic consultant for the course, and he accepted.

The seminar, which has been taught over the years by several members of the department, is structured as a form of role-playing. Students play the role of a team of linguists documenting and analyzing an unfamiliar language. A hired linguistic consultant—in this case, Mutonhori—responds to students' questions in a process called elicitation. Selecting a language has become trickier as Rochester's global student population has increased, but over the years, the course has been taught with speakers of a variety of languages, including Turkish, Albanian, Finnish, Ukrainian, Macedonian, Bengali, and Swahili.

Linguistic description is not the same thing as documentation, Grimm notes. But the two practices are closely related, and she adopts the view that skills in documentation—involving the collection, annotation, and storage of primary audio and video data—require skills in description, which is concerned with the rules and patterns underlying elements such as grammar, structure, sound, and vocabulary. Despite the course's title, by the end, students will have acquired important skills in data collection.

On a typical Thursday afternoon in the seminar, the students arrive with pages of charts. Some of the charts include long columns of English nouns, and adjacent to that column, blank columns for Ndebele translations in singular and plural forms, in forms accompanied by possessive pronouns and adjectives. Another chart lists numbers, beginning with zero to 20, then jumping to 100, 1,000, 10,000, and so on.
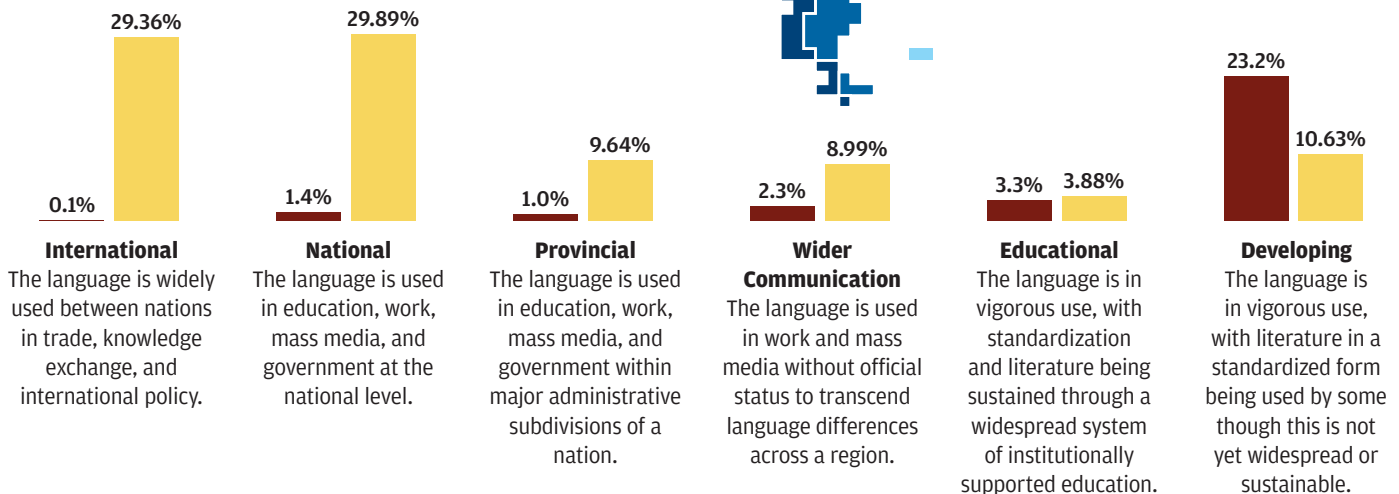
Rebecca Everson '16, a dual major in linguistics and computer science from Rochester, Michigan, says the students work with nouns long before they tackle verbs. "Nouns are the building blocks and verbs are the connectors," she says. "We begin with, *(Continued on Page 34)*
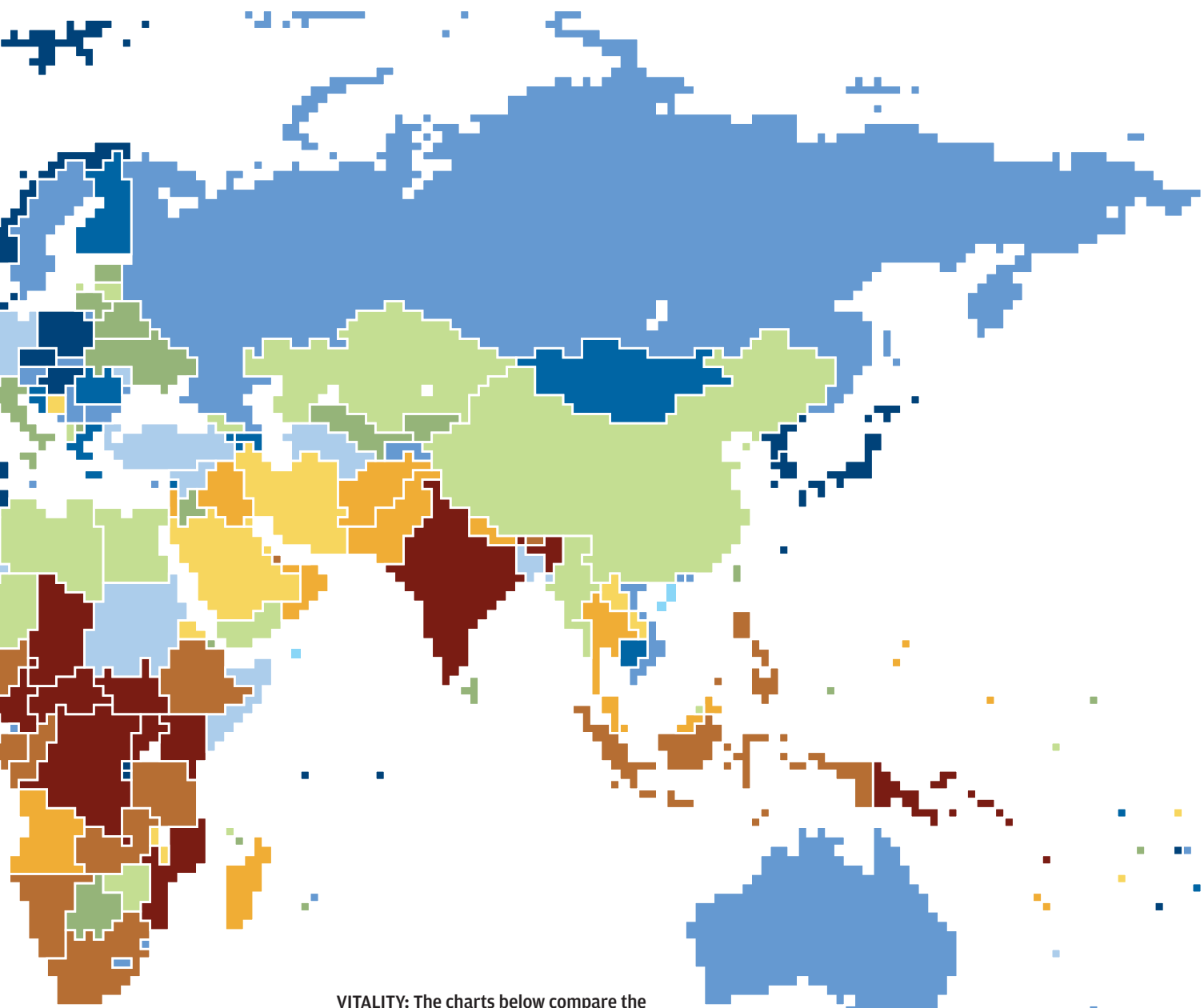
0.900 – 0.999 probability that two randomly selected people will have different native tongues.

0.800 – 0.899
0.700 – 0.799
0.600 – 0.699
0.500 – 0.599
0.400 – 0.499
0.300 – 0.399
0.200 – 0.299
0.100 – 0.199
0.000 – 0.099

DIVERSITY: Colors on the map indicate the variety of languages spoken in each country. Deep blue represents countries with little diversity—most people speak the same native tongue—while deep red represents those whose populations speak many different languages.
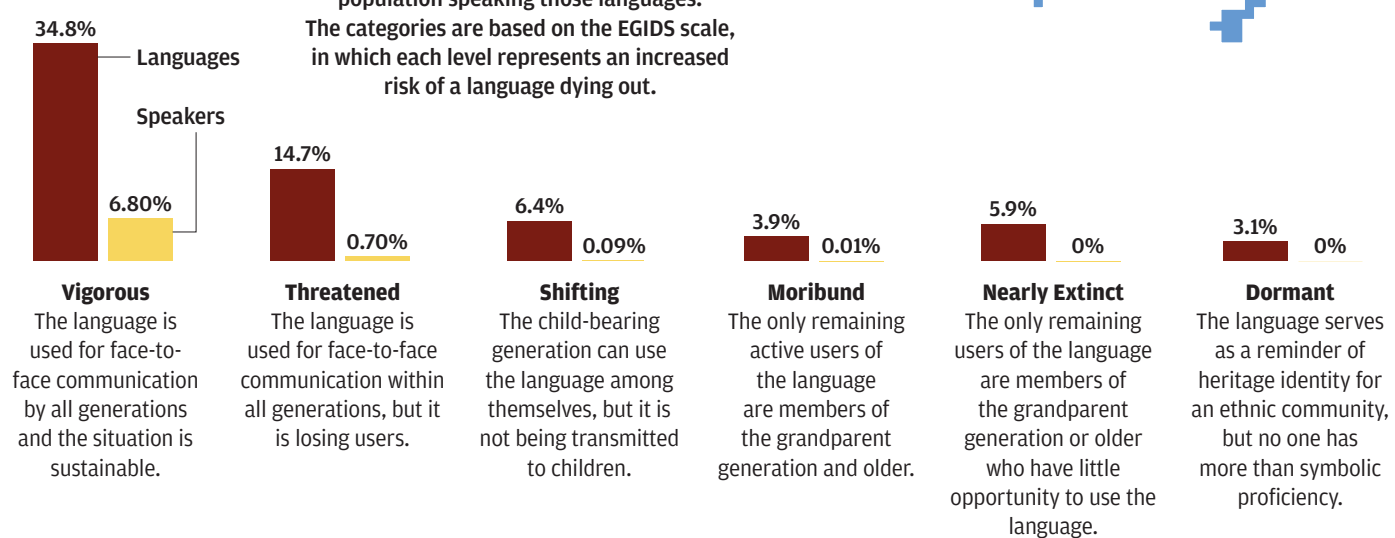
A World of Words

There are about 7,000 languages in use around the world today, according to the *Ethnologue,* a definitive source of information about languages around the world researched and compiled by the Dallas, Texas, based organization SIL International. It's expected that by the end of this century, as many as half of the world's languages will have fallen out of use. Many endangered languages are sparsely, if at all, documented.

International

0.1% 29.36%

The language is widely used between nations in trade, knowledge exchange, and international policy.

National

1.4% 29.89%

The language is used in education, work, mass media, and government at the national level.

Provincial

1.0% 9.64%

The language is used in education, work, mass media, and government within major administrative subdivisions of a nation.

Wider Communication

2.3% 8.99%

The language is used in work and mass media without official status to transcend language differences across a region.

Educational

3.3% 3.88%

The language is in vigorous use, with standardization and literature being sustained through a widespread system of institutionally supported education.

Developing

23.2% 10.63%

The language is in vigorous use, with literature in a standardized form being used by some though this is not yet widespread or sustainable.

VITALITY: The charts below compare the share of the world's languages in each of 12 categories to the share of the world's population speaking those languages. The categories are based on the EGIDS scale, in which each level represents an increased risk of a language dying out.

34.8% Languages / **6.80%** Speakers	**14.7%** / **0.70%**	**6.4%** / **0.09%**	**3.9%** / **0.01%**	**5.9%** / **0%**	**3.1%** / **0%**
Vigorous The language is used for face-to-face communication by all generations and the situation is sustainable.	**Threatened** The language is used for face-to-face communication within all generations, but it is losing users.	**Shifting** The child-bearing generation can use the language among themselves, but it is not being transmitted to children.	**Moribund** The only remaining active users of the language are members of the grandparent generation and older.	**Nearly Extinct** The only remaining users of the language are members of the grandparent generation or older who have little opportunity to use the language.	**Dormant** The language serves as a reminder of heritage identity for an ethnic community, but no one has more than symbolic proficiency.

INTERDISCIPLINARY: Rebecca Everson '16 (center), a dual major in linguistics and computer science, sees opportunities to improve the tools of language documentation, such as software often written by computer scientists without a strong linguistics background.

(Continued from Page 31) for example, 'apple,' then 'apples,' then 'two apples,' then 'your apples,' 'my apples,' and eventually, 'I dropped the apple.'"

The students take turns eliciting translations from Mutonhori, recording his responses in oral as well as in written form, using the International Phonetic Alphabet, or IPA. As they listen and write, they take note of patterns that emerge. When they get to numbers, Mutonhori explains the way in which English, which along with Ndebele and Shona, is an official language in Zimbabwe, has seeped into Ndebele.

If you continued with the patterns that govern teens, then multiples of ten, and hundreds, he tells the class, "You could spend minutes just trying to say two-thousand." Grimm interjects to explain that the morphology of numerals is consistent across hundreds of Bantu languages. Although all were originally founded on a base-five system, derived from the human hand, Bantu language speakers have now shifted to a decimal system, "a trend that is observed all over the world," she says.

Mutonhori says that working with the class has led him to appreciate Ndebele in a new way. "Ndebele is a language I know from the back of my hand," he says. "When I speak in front of the students, they'll come up with things that I already know, but by looking at patterns. The way they have learned to come up with what makes sense—it's very interesting."

Mutonhori's love for the language is rooted in personal history and heritage, but also in some of the features of Ndebele itself. "It's a very poetic and expressive language," he says.

His enthusiasm is palpable. "He's really excited about his language," Everson says. "That helps us be really excited about asking the questions about it. He's always giving us new information, and sometimes we forget to press 'record,' because we're so absorbed in what he's trying to convey."

Outside of class, the students enter written and oral data into computers using a specialized linguistic software called Praat, which helps them to analyze patterns in sound, the composition of words, sentence structure, and other linguistic elements.

In the linguistics department lounge, shortly before class, Everson pours over data with Emy Lin '16, a senior from Glastonbury, Connecticut, who, like Everson, is a dual major in linguistics and computer science. They talk about what they've found, and some of the challenges that they and the other students have faced. Working on a laptop, Lin calls up a spectrogram that Praat has

produced from her recording data and shows how the spectrogram will help her to elicit phonetic properties of Ndebele. Everson points to a series of blue lines swooping upward and downward across a series of spectrograms. She explains the way in which the lines illustrate tone.

"Tone matters in this language, which is something that took us a little while to figure out," says Everson. Ndebele has a sing-song quality, and when the students want to clarify tone, Lin says, "we ask Farai to hum the words."

There are other aspects to Ndebele that pose challenges. It's a so-called "click" language, in which a series of clicking sounds serve as consonants. And while the students may have encountered languages with two, or maybe three, "genders," Ndebele, they've discovered, has many more than that.

To help solve such puzzles, the students are permitted to consult sources on Bantu languages. But by the end of the semester, they will have constructed an overview of the basic features of Ndebele based almost entirely on the data they've collected and analyzed in their work with Mutonhori.

"It's not a lot of time, but they manage," says Grimm. McDonough, who has taught the language description seminar as well, says the students often begin "in a state of shock. How can we possibly do this?, they wonder. Our job is to help them understand that what they've learned here over the past four years actually enables them to do this task."

A mong the more difficult challenges of training students in language documentation is preparing them to work in indigenous communities. As for this aspect of documentation, Grimm comes with a sterling credential. As a doctoral student at Humboldt University in Berlin, she won a grant from the Volkswagen Foundation's Documentation of Endangered Languages program, or DoBeS, as a participant in a fieldwork project in Cameroon that took place over a five-year period.

"It's a very difficult grant to get," says McDonough. According to the senior scholar, the hiring of Grimm is "a real coup. We're thrilled to have Nadine here because of the training she received under the DoBeS project."

From 2010 to 2015, Grimm spent months at a time in southern Cameroon as part of a team of three linguists, local French- and Gyeli-speaking interpreters, and members of the Bakola-Bagyeli community of hunter gatherers. Her research, focused on Gyeli grammar, entailed considerable documentation of the language, which is spoken by an estimated 4,200 people, and is considered threatened. The Volkswagen Foundation filmed a documentary of the work of Grimm and her colleagues, as part of their project. In it, Grimm reflected on the dynamics of economic and social change, and language evolution and loss.

In southern Cameroon, much like in Mutonhori's native Zimbabwe, multilingualism is the norm. "It's a setting where you have eight or nine languages in one area, and where everyone speaks several languages. You meet one person, you speak one language, then you meet someone else, you speak a different language," she says. There's also what's called "code switching," or shifting from one language to another and back again in a single conversation.

The jostling of so many language communities makes southern Cameroon an especially valuable site for research on the dynamics of language evolution and change. Language loss often conjures up images of Western domination. But in many parts of the world, such as southern Cameroon, language loss proceeds gradually, as one ethnic group is displaced and subsumed by another. Cameroon is undergoing economic changes that have threatened the livelihood of the Bakola-Bagyeli. In the coastal city of Kribi, a large port is under construction. As forests are cleared for the project, the Bakola-Bagyeli have been displaced and compensated with jobs and modern housing in Kribi. "In the course of this massive change," Grimm says in the documentary, "they also adopt other languages of the area, and that ultimately leads to language shift and language loss."

There are approximately 500 Bantu languages, of which Gyeli is only one. But it has unique features, underscoring that the significance of a language, from a linguist's perspective, often bears no relationship to its prominence or vigor.

"The vocabulary of Bagyeli is quite different" from that of many Bantu languages, Grimm says. The Bakola-Bagyeli are hunter gatherers, whereas most Bantu language speakers are farmers. They've invented hunting tools and techniques, and have developed an intimate knowledge of plant life, all unknown in other communities—and, necessarily, an entire vocabulary around such esoteric knowledge and skills. Their knowledge of plant life, some of which has been shown to have medicinal value, has attracted the interest of Western pharmaceutical companies. During her time in Cameroon, it wasn't unusual for Grimm to be mistaken for someone working for such an enterprise. It happened, she says, "all of the time."

As part of their documentation, Grimm and her colleagues worked among Gyeli speakers in multiple contexts. They documented conversations among groups, dialogues, storytelling, and explications of daily activities, from hunting to children's games. That's an important practice in documentation, she stresses, and part of what distinguishes it from the mere collection of a relatively static group of words and rules. Video and audio recordings are designed to depict "language as it is spoken naturally in the language community," she says. Spoken language is full of nuances that are derived from context. Those nuances provide linguists with rich insight into some of the core questions motivating language study—questions concerning the relationship between language and social relations, psychodynamics, how language evolves, and the ways in which humans acquire and process language.

Movements toward language preservation and revitalization have taken hold around the world. But they face enormous odds. Few expect that the displacement of the Bakola-Bagyeli, for example, will reverse itself.

"This work, in 100 years, will be what's left," says Grimm at the close of the documentary, of the data that she and other linguists collected that will be housed at the Max Plank Institute for Psycholinguistics Language Archive in the Netherlands. "There won't be a chance to come back and study the nature here. The Bakola will be alive—hopefully—but they'll be different."

Stories like this one exert a strong pull on linguistics majors, says Jeffrey Runner, a professor of linguistics and of brain and cognitive sciences, and chair of the linguistics department. Language loss "taps into something." Students investigating endangered languages "feel like they're doing something that's valuable. There's the social angle of helping save endangered languages, but there's also the scientific angle of finding new features of language that we don't know about."

"Language documentation definitely interests me," Everson says, reflecting on her long-term plans. She has accepted a job at a software engineering firm in New York City, which she will begin soon after graduation. She'll stay involved in linguistics through a project she's working on with Nadine Grimm's husband, Scott Grimm. He's also a member of the linguistics department and is producing a dictionary of Dagaare, which is spoken in parts of Ghana and Burkina Faso. Everson's role, as she describes it, is "to try to make software to make dictionary creation a little bit easier."

"I'm hoping to go back and get a PhD in documentation and revitalization," she adds. She's attracted by the prospect of fieldwork, and convinced of the urgency of language preservation. There's another, more basic reason, too. "Language is part of a people," she says. "And letting a language die is not OK." ®

OPTICAL VISIONARIES: Students and faculty from the Institute of Optics, historically, have found entrepreneurial outlets for the expertise that they—like the group studying image formation in this undated photo—acquired at Rochester.

An Optical Family Tree

Tracing the companies with connections to the Institute of Optics.

By Kevin Wesley

When Duncan Moore '74 (PhD), the Rudolf and Hilda Kingslake Professor in Optical Engineering Science, three years ago began doing some research for the 60th anniversary of the founding of the optics company Tropel, he made an intriguing discovery.

Tropel—now a division of Corning Inc., and one of the world's leaders in customized precision optical instruments—was formed by Robert Hopkins '45 (PhD), then a professor at the Institute of Optics. Moore's research indicated that former students of Hopkins went on to found 15 optics companies. He surmised that Hopkins, who later returned to the University's Laboratory of Laser Energetics and continued teaching at the institute after creating Tropel, had intentionally instructed students in the ins and outs of starting and running a company.

Moore was wrong.

Despite many interviews with Hopkins's former students, he "could not find one single instance" where Hopkins had talked explicitly with his students about launching their own businesses. Instead, alumni told Moore that it was seeing what faculty at the institute were doing that gave them the inspiration and tools to start their own companies.

A lot of the alumni, Moore remembers, said something like "I saw Bob doing something and thought, 'I could do that.'"

Apparently, they were right. More than 150 alumni and faculty members of the institute have started their own companies. And the University and the broader Rochester business community have long played a leading role in creating and maintaining some of the world's most successful optics firms. Along the way, they've created a tight-knit community within the sphere of optics.

Founded in 1929, the institute was the first academic program

The Business of Invention

Even as a child, Stephen Fantone '79 (PhD) was fiddling with optics. He had a dark room and as a teen was grinding and polishing mirrors and building telescopes.

Today, he's the founder, president, and CEO of Optikos Corp., a company based in Wakefield, Massachusetts, that is the world's largest maker of equipment used to measure optical image quality. He has more than 65 patents to his name and serves on many corporate boards.

He says that the roots of his entrepreneurialism reach back to his graduate student years. He saw faculty members running their own businesses, and he himself took on consulting work while still a student. The combination of in-depth exposure to the local business community and the entrepreneurial success of faculty convinced Fantone that he, too, could venture into business.

He, along with other alumni, lectures to students when he is in Rochester.

"I've seen the skills of these students really blossom over the years," he says. "These kids are far better at presenting themselves."

And they present themselves so well that he has more than 15 institute alumni on his staff at Optikos.

"I have a lot of choices from where I can hire people," he says. "There's an intangible aspect to it. They're all smart and motivated—and they have a passion for optics." —Kevin Wesley

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focused on optics as a field. Since then, some 2,800 students have graduated, the largest group of optics degree–holders in the country.

"The people who leave Rochester never really leave Rochester," says Alan Willner, president of the Optical Society, known by the society's moniker, OSA. "Rochester people are famous for their camaraderie and loyalty to the institute. They're proud of being a product of the institute. They wear it as a badge of honor."

Moore agrees. "We tell potential students, 'Look, if you graduate from the Institute of Optics, you can call any alumnus, regardless of their station in life. They'll take the call.'"

Richard Pfisterer '79, '80 (MS) vouches for that. After graduating, he worked in the aerospace industry for several years, but grew to feel burned out. Eventually, he started his own company, Photon Engineering, in Tucson, Arizona. It's a leading optical software firm. As he was considering whether to start the business, he knew he had a safety net in the institute.

"I don't think any of us walk off the cliff without throwing a handful of dirt first to see if something is there," he says. For Pfisterer, meeting someone else from the institute means that "somehow we were related. You always knew there would be a classmate or professor who would help you solve your problem."

Ultimately, he says, it's in the culture of the place. "As a student, you see faculty come and go. You see them having businesses. I think it's about being in an environment where you see people doing this and coming back to talk about it. You think, 'He's teaching this, but he's also doing this.'"

Today, efforts to teach optics students about business are more intentional. Students are encouraged to take courses in business and entrepreneurship. Writing courses teach students how to communicate about technical knowledge with different audiences.

Moore's research indicates that 70 to 80 percent of institute alumni today are in industry, with 10 to 12 percent in research positions, and the remainder in academic posts.

"Only three people have ever retired from the institute," says Moore, noting that, in addition to creating companies, faculty are often recruited away. "That is amazing." ®

Kevin Wesley is a Rochester-based freelance writer.

30
San Francisco Bay Area

5
Los Angeles Area

7
Tucson

Coast to Coast

In the six decades since Robert Hopkins '45 (PhD), then a professor at the Institute of Optics, Jack Evans '39, '49 (Mas), and James Anderson created their optics company Tropel, more than 150 alumni and faculty members of the institute have started their own businesses. Considered one of the world's leaders in customized precision optical instruments, Tropel is now a division of Corning Inc.

While not all of the companies that trace their roots to the institute are still in business on their own, the University and the broader Rochester community have played a leading role in creating and maintaining some of the world's most successful optics firms.
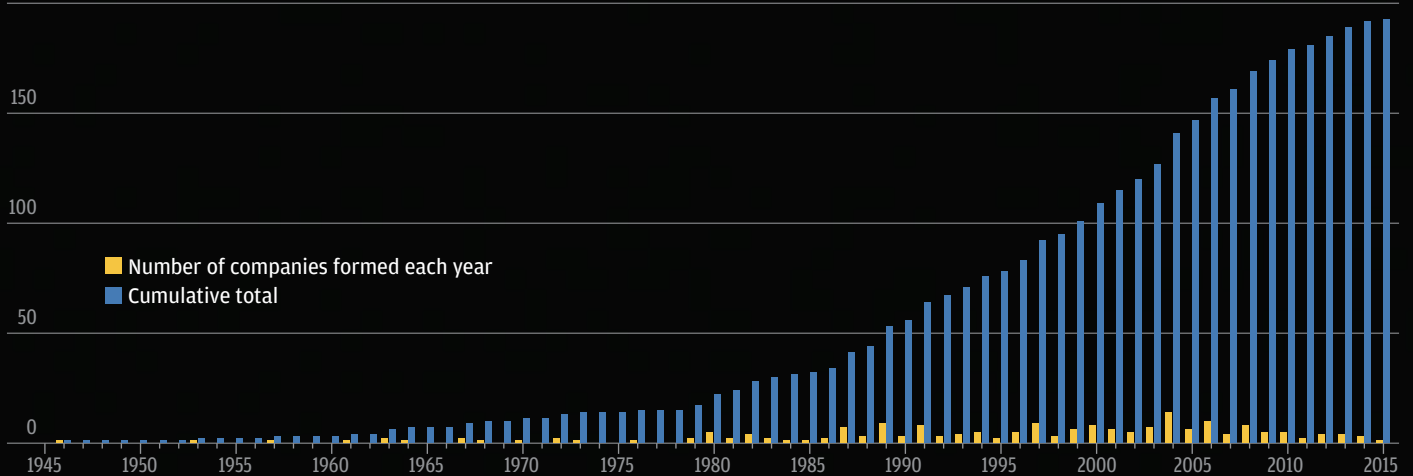
As the charts indicate, the heaviest concentrations of University-connected enterprises are in the Rochester and San Francisco regions, but the companies can be found across the United States.

STEVE BOERNER

54
Rochester Area

7
Denver Area

10
Boston Area

5
Durham Area
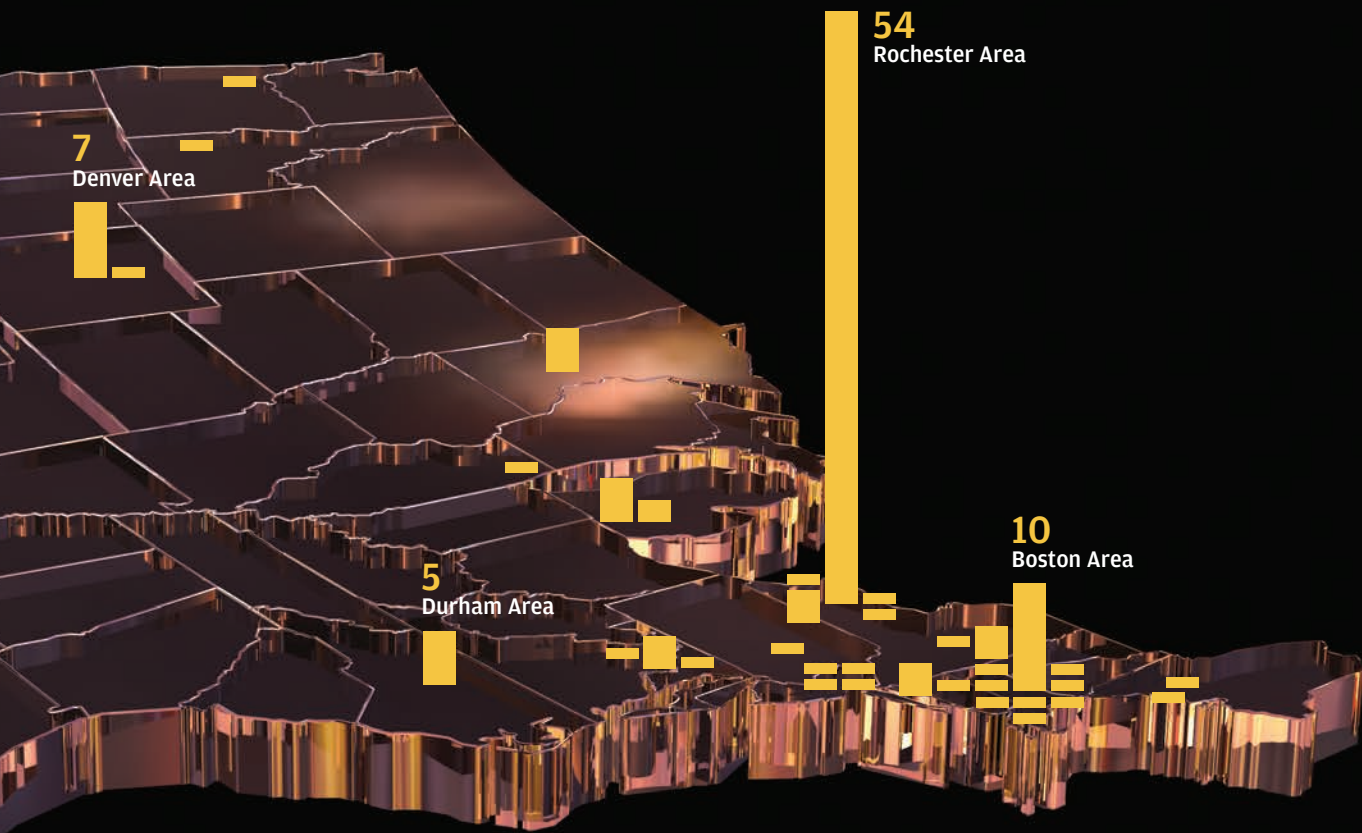
Growth Curve

The number of companies formed by Institute of Optics alumni has grown steadily since the 1960s, with a notable uptick beginning in the 1990s.

200 companies formed

150

100

■ Number of companies formed each year
■ Cumulative total

50

0

1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015

Delving into DATA SCIENCE

Students complete their first year in Rochester's new program for harnessing the power of digital information.

By Kathleen McGarvey
Photographs by Adam Fenster

When it comes to tackling social problems and fueling business, experts agree that data—the vast volume of data that the digital world generates—increasingly is indispensable, a resource that scholars, business leaders, and consumers have only begun to tap.

In response a new field has emerged, called data science. It's the creation and application of new methods for collecting, curating, analyzing, and making discoveries from large-scale data, in areas such as energy and the environment, economics and politics, health care, and marketing. The areas of application are only limited, really, by data scientists' imaginations.

This spring, the inaugural crop of students in Rochester's new data science programs—at the undergraduate and master's degree levels—are completing their first year of study at the Goergen Institute for Data Science, a program of the Schools of Arts & Sciences. Some are completing their degrees, having finished a year of graduate study or having gotten started early by taking prerequisites for an undergraduate degree. Others are just beginning. But what unites them all is an enthusiasm for discovering ways to make the most of information.

"We want to teach the students the fundamentals—computer science and statistics—and then let them explore some of the applications in different areas. That's what I think is unique," says Henry Kautz '87 (PhD), the Robin and Tim Wentworth Director of the Goergen Institute for Data Science and a professor of computer science. He notes that programs emerging at other schools are often more specialized—dedicated to business analytics or health analytics, for example—but that the Rochester program provides a strong foundation for every area of focus.

Having a degree in data science "tells employers that these are people with a broad range of skills on the statistics side and the computer science side. They're highly in demand," he says.

That's something to which Greg Munves '04 can attest. He's president and chief operating officer of 1010data, a New York–based company dedicated to big-data discovery and data sharing. "You need folks with Renaissance skills," he says. "So instead of searching through people deep in computer science but with a little statistics or math, now you get people who have just the right amount of proficiency in each of those disciplines."

Two of this year's graduates are headed to 1010data. "For the size company we are, we have a disproportionate number of U of R alumni involved," says Munves. "With the advent of the data science program, it's become even more relevant for us to look to U of R for good talent."

And once the program was launched last fall, students voted with their feet. Original predictions for the program's first year were for five graduate and 12 undergraduate students. Instead, year one brought 26 and 30 enrollees, respectively. And those numbers could double next year, says Kautz.

The long-term goal for the master's degree program is 50 students—the number for which the lab space was designed. For the undergraduates, there is no ceiling.

"We'll grow the program as much as the students demand," Kautz says. ®

Ling (Kelly) He '17

Degree: Bachelor's in data science
Data science concentration area:
Computer science, statistics, and mathematics
Hometown: Hangzhou, China

When Ling (Kelly) He '17 arrived at Rochester, she was thinking about majoring in economics or math. But she also became interested in the concept of "big data"—the huge data assets generated by digital life that can reveal important patterns. When she learned that the University was kicking off a new program, she wasted no time in signing up. Now she's a double major in data science and mathematics, with a minor in Spanish.

Last summer, He began doing research under Jiebo Luo, an associate professor of computer science with expertise in data mining, machine learning, and other areas of investigation for data science. The project to which she contributed used data collected from social media to connect students who aren't interested in STEM—science, technology, engineering, and mathematics—with people who could nurture their curiosity.

"It's amazing how you can make use of resources to find a pattern, or do something for the social good or for other applications in real life," He says.

She didn't know much about issues surrounding STEM education when she first joined the project, but now, she says, she's "more passionate about it" than she ever thought she would be. "I can see the power of data science because I know more about it."

DATA-DRIVEN: "I can see the power of data science because I know more about it," says He of her first year in the program, during which she contributed to research using social media data to connect students with mentors who can pique their curiosity about science, technology, engineering, and math.

This summer she has an internship in New York City with business-management consulting firm Ernst & Young, in a technology-advisory program of the company's financial services office.

"There's a lot to learn. It's a new field with a lot coming out really quickly. It's very fast-paced. Sometimes it can be overwhelming because we're still learning the basic techniques. It can be overwhelming—but that's what keeps you learning and going forward."

Ian Manzi '18

Degree: Bachelor's in data science
Data science concentration area: Economics
Hometown: Kigali, Rwanda

Ian Manzi '18 has been intrigued by computers ever since he was a child. But it's not computers alone that spark his interest.

"A lot of people think of people interested in computer science as 'antisocial'—people and machines. But I am not that," he says. "I feed off the energy of being with people."

He's convinced he has found an ideal fit in data science for his analytical mind and gregarious personality.

Manzi arrived at Rochester unsure of what he wanted to pursue. He started with a major in computer science, but he found it too abstract. And so he moved this year to data science, which he says keeps the quantitative aspects of programming that appeal to him but also offers more opportunities for practical problem-solving.

Last year he completed an internship as an operations manager in his hometown of Kigali, Rwanda, helping local schools to transition to digital record-keeping.

"Marketers and programmers don't speak the same language," he says. "I understand both, and I helped the project to grow."

It's the act of communication that seems to fascinate Manzi most. He says that he wants to create computer platforms that help people converse across disciplines. "The answers we need for societal problems may be on the 'other side'" of divisions, he says, and communication is essential.

Fostering conversations and looking for answers is something he knows a thing or two about. This spring, Manzi and Derrick Murekezi '19, a geology major from Nyagatare, Rwanda, received a $10,000 grant from Davis

MAKING CONNECTIONS: Drawing together different fields and points of view is part of what attracts Manzi to data science. "I feed off the energy of being with people," he says.

Projects for Peace, a competitive national program that promotes peace and intercultural understanding. The two will use the funding to implement their summer project, "Critical Thinking for Peace: Sustaining Peace in Post-Conflict Regions," in Rwanda this July. They'll plan, set up, and operate a young leaders' peace camp for high school students, where camp-goers will reflect on Rwanda's 1994 genocide.

And while he didn't conceive of the project as having a data science dimension, he's beginning to see ways that he might potentially work that in.

One thing data science has cultivated in him, he says, is the "ability to relate to different fields."

Anthony Margetic '16

Degree: Bachelor's in data science
Data science area of concentration: Biology
Hometown: Syosset, New York

Tyler Trine '16

Degree: Bachelor's in data science
Data science area of concentration:
Brain and cognitive sciences
Hometown: Wolcott, New York

This summer, two of the data science program's first new graduates will be headed to Manhattan, to begin working at data discovery and sharing company 1010data.

Anthony Margetic '16 and Tyler Trine '16 got their feet wet at the company last summer, when they were interns there.

"It was exciting to be there for just two and a half months," says Trine. "I want to go along for the ride."

They're already off to a roaring start, having devoted themselves to the program the year before it was even launched, structuring their schedules to get prerequisites out of the way before the program began. "It's been a jam-packed two years," says Trine.

But those two years have given them a new way of seeing the world. "Data science is a way of thinking," says Margetic. "You want to get to the questions that no one else is looking for."

It's the fluidity and interdisciplinarity of data science that first drew him. "I love learning about all kinds of stuff. I didn't want to be stuck in one field," he says.

For Trine, discovering the field of data science was finding an intellectual home for the kind of thinking he was already doing. He had started reading philosophy and picked up a book on semiotics, the study of how we make meaning.

NEW YORK, NEW YORK: With new degrees in hand, Trine (left) and Margetic are Manhattan-bound, to start work at data discovery and sharing company 1010data.

The linguistics minor was intrigued by "what it means to be informed," he says. "It became a preoccupation. I wanted to understand how people do it on a deep level, how we take in rich sources of information intuitively."

Says Trine, "It used to be that data was scarce, and the main enterprise was squeezing the most out of it. Now we're data-rich, but still information-poor." Data scientists like Margetic and Trine hope to change that.

Margetic says that having the phrase "data science" attached to a degree helps set him apart because it highlights a breadth of skills. "If you're a math person or an engineer, you have a subset of the skills I have as a data scientist."

Francesca Romano '16 (MS)

Degree: Master's in data science
Data science area of concentration: Computation and statistical methods
Hometown: Rotterdam, New York

When Francesca Romano was an undergraduate at Siena College, she majored in math, with a minor in computer science.

"The thing I loved about math, the thing that drew me to it, was using my problem-solving skills and applying them to all kinds of problems," she says.

Data science seemed to her the best way to continue to do that. This spring, the Rotterdam, New York, native is earning her master's degree in the field.

"It's made me confident in my analytic and programming abilities. Everything that we're learning, we can apply to all sorts of different problems—health care, market research. It's a really diverse degree."

Although opportunities are plentiful, job hunting can actually be tricky, she says. While a lot of employers are realizing they need to hire people to help them make data-driven decisions, they're not yet experienced in how to describe what they're looking for. "I had to be creative in seeing what companies are calling these positions," she says.

Her creativity has paid off. She's accepted a position in cardiovascular services at Ellis Hospital in Schenectady, New York, where she'll be analyzing data from cardiovascular patients to identify trends or patterns that may be useful to the hospital in providing care.

"Society is becoming more and more tech-savvy and technologically advanced," she says. "We're collecting massive amounts of data, from phones, from everything we buy online, and more. Even if you're not totally aware of what data science is and how it applies to you, I think it's important to know that it's become an important part of business and decision making."

One thing Romano particularly likes about Rochester's program is the range of students. "I think it's been great that the first year they accepted people from so many different backgrounds," she says. "It's been really nice to see that everybody has a bit of a different strength—and that we can combine our strengths to accomplish something."

PROBLEM SOLVER: Romano says that data science draws on her problem-solving skills. "It's made me confident in my analytic and programming abilities. Everything that we're learning, we can apply to all sorts of different problems—health care, market research. It's a really diverse degree," she says.

Tiffany Sinclair '15, '16 (MS)

Degree: Master's in data science
Data science area of concentration:
Health care
Hometown: Evanston, Illinois

Wherever you turn, data science is there, says Tiffany Sinclair '15, who this spring is completing her master's degree in data science.

"It really is in every field," she says. "We've collected so much information over the decades, and now we finally have the ability to do something with it."

For Sinclair, that something is contributing to public health. Her goal is to become a data analyst in a health-related position, and she plans to find opportunities to travel and examine how health care works in different countries.

The master's program concentrates on methods, she says, teaching students how to glean useful information from data and how to apply those skills in different areas.

Sinclair says she's always loved problem-solving and sorting through information to find meaning and draw conclusions. Studying data science has only sharpened those skills.

"It's a lot of fun—and challenging, not having come from a computer science background," says Sinclair, who as an undergraduate was a biology major and favored the pharmaceutical and analytical aspects of biology.

She says her favorite feature of the program

EARLY ADOPTER: Sinclair, who plans to pursue a data science career focusing on public health issues, says it's exciting to be in on the ground floor of an emergent field. "There's a sense that the field is really alive, and you can drive it forward," she says.

is that while the basic concepts stay the same, each class comes at them "from a different angle."

And it's exciting to be part of a brand-new field. "I have a sense of knowing so much—and of not knowing anything at all, because everything is still being studied," she says. "There's a sense that the field is really alive, and that you can drive it forward."