



NYUAD
RESEARCH
REPORT
2013-14



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Four years ago, NYU Abu Dhabi opened with the ambition to become a global center for research, scholarship, and artistic work. In that brief time, as the following pages demonstrate, we have reached a range and a level of quality in these activities that none of us would have imagined then.

Our faculty, together with the researchers invited to participate in the NYUAD Institute, are engaging in paths of discovery and creativity that are already shaping — across the humanities, social sciences, natural sciences, and engineering — how the world responds to critical issues of our time. Groundbreaking translations of Arabic literary works and the production of paradigm-shifting dramatic forms; research into renewable energy, genomics, climate modeling, and computer security; and investigations into the potential of new technologies to facilitate Sub-Saharan economic development; and innovative strategies for addressing vital areas of public health are among the areas in which the University is already exerting significant impact.

Moreover, this success in research, scholarship, and artistic work is all the more impressive for it broadly includes the involvement of our undergraduate students, motivating and honing the creative talents of these individuals who are among the world's brightest from more than 100 nations, and who are eager to develop the rigorous, sensitive, and complex imaginations that world-serving innovation requires.

Our first biennial research report in 2012 introduced the scale of our ambition and the scope of our expertise. Two years on, we present a results-driven report as evidence of how far NYUAD research has matured. We feel ever more resolved to advance Abu Dhabi as an idea, education, and research capital of this century.

Al Bloom
NYUAD Vice Chancellor





Over the course of our first four years, NYU Abu Dhabi has built upon the bold vision of the global network university, recruiting the best minds from the world over to learn and engage in knowledge creation for an interdependent global society while simultaneously striving to make Abu Dhabi and the UAE an intellectual, artistic, and innovation hub of the 21st century.

As I look through this book, I see the remarkable accomplishments achieved by our intellectual and creative community. The NYUAD research paradigms are new and, like our institution, built on cross-cultural and interdisciplinary connections — elements that reveal their impact on the contemporary issues of our society.

Our commitment to research has been pivotal in attracting stellar faculty and students. Mentored by dedicated professors, our inaugural class has achieved impressive results with their research culminating in senior Capstone projects. These activities have led to awards and the placement of a large proportion of our students in prestigious doctoral, graduate, and professional programs, or top companies; some plan to start their own companies in the UAE.

Our faculty and research teams have made tremendous contributions to society and helped establish NYUAD as a global research university. Since opening in September 2010, more than 500 publications have been published, more than 50 artistic works have been created and directed, and more than 20 patents filed. Early in 2014 we celebrated the inaugural University Research Conference, during which more than 90 presentations were delivered and more than 40 posters presented by our faculty, researchers, and students. In the years ahead, the launch of our doctoral and graduate programs is sure to enhance many of these activities.

This volume captures the groundbreaking research and artistic activity accomplished during the past two years at the University's Center for Science and Engineering, Sama Tower, and the Downtown Campus. As we say farewell to downtown Abu Dhabi and Mussafah, and to the classrooms, offices, and retrofitted labs and artistic spaces, NYUAD is poised to continue a tradition of excellence in research and the arts at our permanent home on Saadiyat Island.


I am filled with excitement and admiration at what has been accomplished during these initial stages. As we enter the next phase, I congratulate all of our faculty, students, and staff who have created the inspiring projects described in this book through their boundless curiosity, talent, and perseverance.

Fabio Piano
NYUAD Provost



NYUAD INSTITUTE RESEARCH PROJECTS

NYU Abu Dhabi's research projects span the disciplines, but they share a common denominator — they all contribute significantly to scholarship, scientific understanding, and artistic creativity and will play a role in advancing Abu Dhabi as a capital of ideas, research, and education in the 21st century. Through its research initiatives and public programming, the NYUAD Institute has already begun to make its mark as a vital intellectual center of this region — and of the world. In addition to the projects listed here, the Institute has produced a yearbook that catalogues public programs, conferences, and workshops through the Institute's first five years.



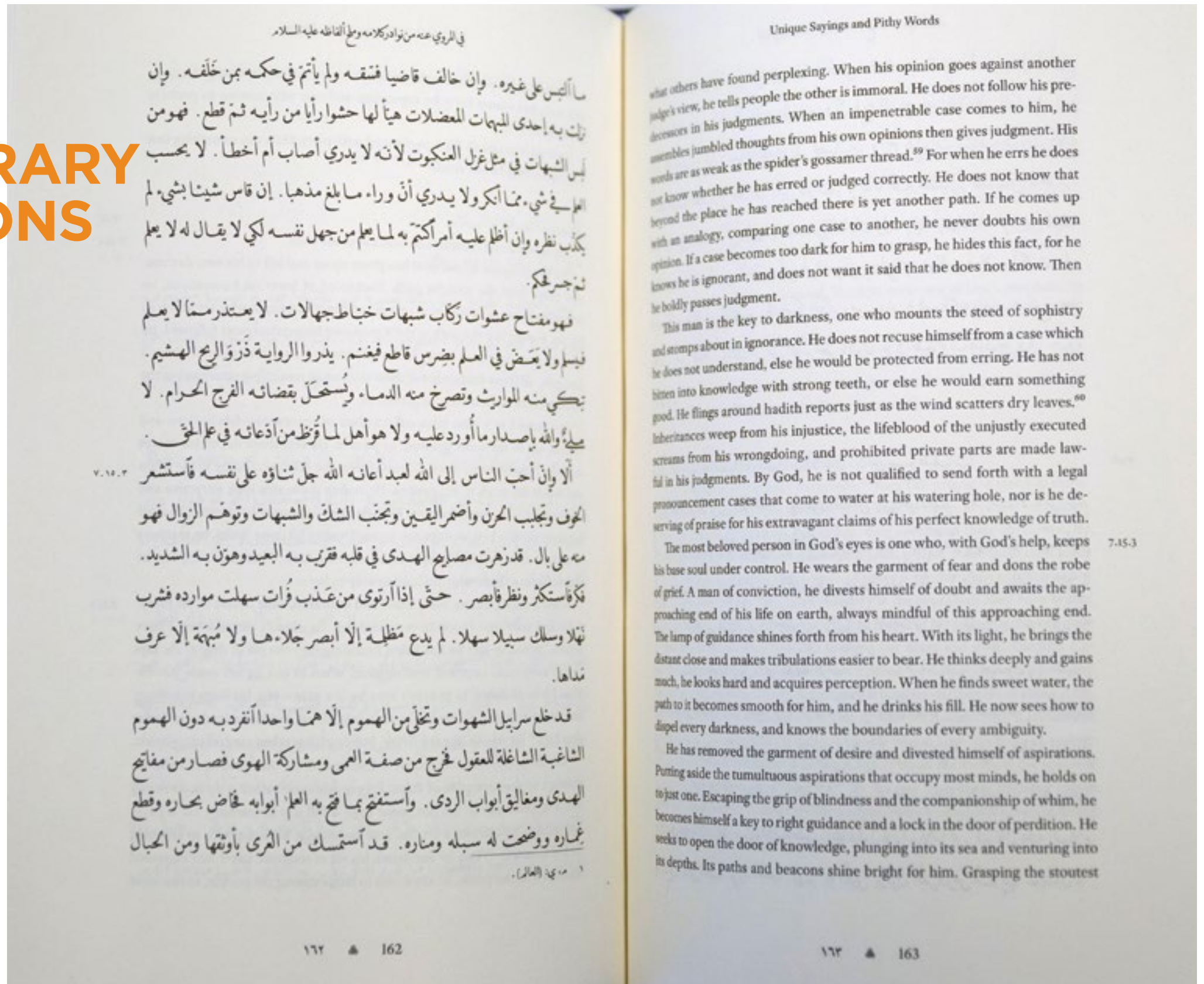
ARABIC CLASSICS IN CONTEMPORARY TRANSLATIONS

The Library of Arabic Literature (LAL) was founded with high ambition: to make the treasures of pre-modern Arabic writing accessible to the world's English speakers through high-quality parallel-text editions. In its first three years, the LAL has published nine volumes – on literature, law, religion, biography, and mysticism – and more are in production.

The project's General Editor is Philip F. Kennedy, an associate professor of Middle Eastern and Islamic Studies and Comparative Literature at NYU Abu Dhabi. He works with seven other scholarly translators, plus a 27-member international advisory board, to ensure meticulous translation and production. The project, in partnership with NYU Press, is supported by a grant from the NYUAD Institute.

As more books are published, the breadth of the Library will expand, said Kennedy, who is well-known in Abu Dhabi from his time as faculty director of the Institute.

“Though eclecticism was not a goal in itself, we decided that we might as well start with some works that have not been translated,” he said. “We did, however, want to be comprehensive ... and as we push forward, we will move closer to that end.”



The LAL has already won high praise, including from the *Times Literary Supplement*, one of the world's top literary reviews. In the October 11, 2013 edition, Lydia Wilson wrote that "...the study and teaching of medieval Arabic thought and literary creativity will be revolutionized" by the LAL's work.

Collaborative translation is not new, nor unique to the Library. But few projects have been as self-consciously cooperative as this one.

"Collaboration is fundamental to the LAL identity," said Executive Editor James Montgomery, the Sir Thomas Adams's Professor of Arabic at Cambridge University. "We're trying to show the world that we can produce high-quality volumes with one name attached ... but the translation in fact represents the work of a lot of different people," he noted.

Managing Editor Chip Rossetti explained the system for bringing a book along: "Every translator works with a board member who is dedicated to the whole process of producing an edition. The board member is there to act as a sounding board for the translator, and to ensure that the translation is up to the standards the editors are looking for."

This kind of work has given LAL Editor Julia Bray, Laudian Professor of Arabic at Oxford University, the opportunity to engage with colleagues in different fields. "As editors, we are learning about each other's disciplines, modes of thought, techniques, procedures," she said.

One forthcoming volume is titled *Two Arabic Travel Books: Accounts of China and India and Mission to the Volga*.

For *Accounts of China and India*, by Abū Zayd al-Sīrāfi, the translator is the Yemen-based scholar Tim Mackintosh-Smith, known for his translations of the travel writings of Ibn Battuta. It is a collection of stories from the mid-ninth and early 10th centuries,

chronicling merchant voyages eastward from the Arabian Gulf.

Mission to the Volga, written in the 10th century by Ibn Fadlān, is being translated by Montgomery. The tale describes the journey of diplomats sent by the Abbasid Caliph of Baghdad to the King of Bulghar, a convert to Islam, whose domain was located on the Volga River. "Ibn Fadlān traveled up past the Caspian Sea, to the upper Volga, where he met with Vikings who were living in the area," Kennedy explained. "Their meeting is an interesting conjunction, and there is some fascinating stuff in the book, like an account of a Viking chief who died and was burned in his boat."

LAL is more than just the books it produces. Once a year, the editors meet in Abu Dhabi for a week-long workshop. They also hold a formal meeting in which they invite scholars not affiliated with the Library to translate poetry and other Arabic

texts in a collective process.

The Library also hosts a yearly public lecture in Abu Dhabi. In December 2013, Montgomery gave a talk entitled "Sheikh Zayed bin Sultan Al Nahyan, Falcons, and Abbasid Hunting Poetry." He read his own translations of Sheikh Zayed's hunting poems and discussed tropes and images that are integral to the Abbasid hunting poetry that is fundamental to the genre.

The yearly lecture provides an opportunity for the editors to see just how important classical Arabic literature is to the local community.

"Being in Abu Dhabi makes us aware that the work we are doing is not disconnected from the people and cultures of the Arabic-speaking world. And that's very important to us," said LAL Executive Editor Shawkat M. Toorawa, an associate professor of Arabic Literature and Islamic Studies at Cornell University. "We could do this in Oxford, Ithaca, Cambridge — but that would be a very different thing." ▀



Executive Editor James Montgomery gives a talk titled "Sheikh Zayed bin Sultan Al Nahyan, Falcons, and Abbasid Hunting Poetry" in December 2013. **LEFT:** Library of Arabic Literature's General Editor Philip F. Kennedy.



Library of Arabic Literature editors

- **General Editor Philip F. Kennedy** is associate professor of Middle Eastern and Islamic Studies and Comparative Literature at NYU Abu Dhabi.
- **Executive Editor James Montgomery** is the Sir Thomas Adams's Professor of Arabic at the University of Cambridge and Fellow of Trinity Hall.
- **Executive Editor Shawkat M. Toorawa** is associate professor of Arabic Literature and Islamic Studies at Cornell University.
- **Managing Editor Chip Rossetti**, University of Pennsylvania
- **Editor Julia Bray** is the Laudian Professor of Arabic at the University of Oxford and Fellow of St. John's College.
- **Editor Michael Cooperson** is professor of Arabic at the University of California, Los Angeles.
- **Editor Joseph E. Lowry** is associate professor of Arabic and Islamic Studies at the University of Pennsylvania.
- **Editor Tahera Qutbuddin** is associate professor of Arabic Literature at the University of Chicago.
- **Editor Devin J. Stewart** is associate professor of Arabic and Islamic Studies at Emory University.



SECURING THE IMAGE AND THE HUMAN

From selfies to war photography, images are increasingly born digital. But as photographers snap and share, most do not realize that the images they post online can be traced back to them using digital forensics. If you are sharing a photo of your brunch on Instagram, this is of little concern. But if you are photographing in a war zone, the stakes are higher.

Citizen-journalists are a main source of information that comes out of conflicts and protests, and digital photography and video are a key mode of their communication. In some cases, these reporters go to great lengths to maintain their anonymity. But their tools can reveal their identity, as every digital camera has its own unique noise pattern, or “digital fingerprint.”

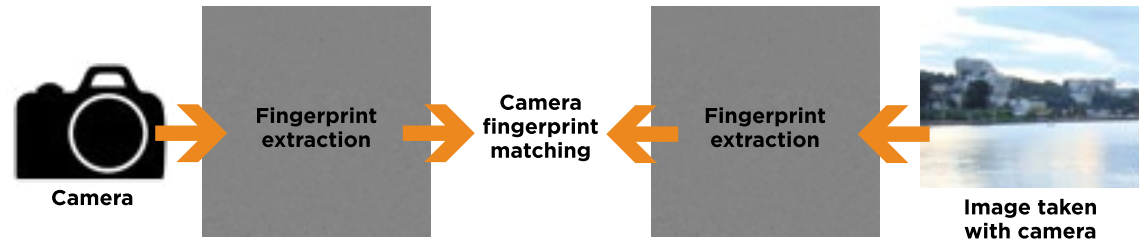
There are two sides to the issue. Digital forensics provide law enforcement an important tool in their fight against crime. But these techniques also leave activists and reporters vulnerable. “People expose atrocities by sending pictures,” Professor Nasir Memon said. “And if those pictures can be connected to a particular camera and thus to a particular individual, that would not be a good thing. So, there is a need for ways to remove this noise pattern and bring anonymity back to photographs.”

Memon is professor of Computer Science and Engineering at NYU School of Engineering and principal investigator of NYU Abu Dhabi’s Center for Interdisciplinary Studies in Security and Privacy (CRISSP-AD). He and his colleagues at the Center recently published a paper that describes techniques that may provide tools to help photographers anonymize their images.

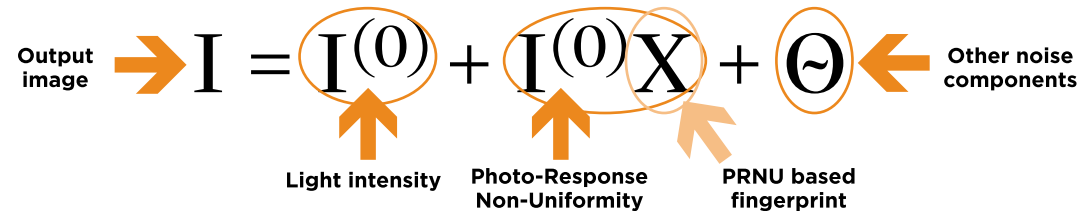
Instead of capturing light on film, digital

Photo by Peter Macdiarmid/Getty Images

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Simplified model of the output



cameras capture images on a photo-reactive sensor that is made up of millions of tiny smaller sensors. (For example, if you have an eight-megapixel camera, the image sensor is made up of roughly eight million smaller photo-reactive sensors. A pixel in a digital photo corresponds to an individual photo-reactive sensor.) Since manufacturing processes are not perfect, the photo-reactivity of each tiny sensor varies; one sensor may be slightly more or less photo-reactive than the one next to it. This minute variability from pixel to pixel gives each individual camera its “digital fingerprint.” In technical language, the pixel pattern is called the photo-response non-uniformity noise pattern.

So, if a digital forensics specialist knows that a photo was taken with a particular camera, the specialist could compare the pixel pattern of that image to other images and determine if they were taken with the same camera, simply by looking at the pixel pattern. It is a complex process, but with the right tools, is possible.

Memon and his colleagues “have applied for a patent for a technique that has proven to be very effective for removing the noise pattern of a particular photo. And this is not only in terms of practice, which can be shown by experimentation,

but even by mathematical analysis,” so that the digital fingerprint has been completely removed from the photo.

This technology could be developed as a filter that could be used on an image after processing, or it could be integrated into a social media platform and be applied to a photo before the image is posted on the web.

In addition to their work with digital images, the CRISSP-AD team is managing projects that consider the “human aspect” of security. Though there seems to be general awareness that computer users should not click on links from senders they do not recognize, users still fall for these kind of attacks all the time. Many high-profile attacks – even those that have compromised large corporations and embassies – have started simply with a well-crafted email. “You can have all the technology in the world, but at the end of the day, a human has to do the right things,” Memon said.

He recounts a study done by a large defense contractor in the United States. The company conducted a phishing attack on its own employees to see how they would respond. About 30 percent of the employees fell for the scam, and the company ran a training session for the employees who failed. This process is called embedded training, which



Nasir Memon, principal investigator of CRISSP-AD.

is supposedly one of the most effective ways of instruction because offenders receive feedback on their mistakes almost immediately.

After training, the company phished again. To the surprise of many, the results were essentially the same. Twenty-six percent of employees fell for the ruse in the second round. They phished a third time. Again, 26 percent failed. Most of the people who clicked on the link the second and third times were new offenders. But about 10 percent had made the mistake every time. Why?

The answer may have more to do with psychology than technology.

The approach of computer security up to this point has assumed that people click on malicious links due to a lack of awareness. But Memon thinks that there must be something more to the issue: “If 10 percent of the people clicked on a malicious link every time and were told about their mistake after making it, then it can’t simply be an issue of awareness. And if 10 percent of the population is susceptible to these attacks, then this is a huge problem, and somehow we need to better understand how to fix it.”

In their own experiment done with students at multiple campuses including the American University of Sharjah that was similar to the study

MEMON CONTEMPLATES HOW SECURITY SETTINGS COULD BE TAILORED TO INDIVIDUAL PERSONALITIES RATHER THAN HAVING THEM THE SAME FOR EVERYONE

done by the US defense contractor, CRISSP-AD researchers conducted a personality study on the multiple offenders to see if they had similar personalities. “We found some strange things,” Memon said. “For instance, people with neurotic tendencies were more likely to click than those without neurotic tendencies. To us, that didn’t make much sense: we thought that people with neurotic tendencies would be more paranoid and would be less likely to click. But then it could have been because the message had some urgency to it.”

Memon says that CRISSP-AD may conduct more studies to see if there are differences between behavior here in Abu Dhabi and other parts of the world. “Our thinking is that the defenses we provide today are a kind of one-size-fits-all approach; they’re not tailored to individuals,” Memon explained. “Our privacy settings, our default security settings, are all the same from person to person.”

Memon contemplates how security settings could be tailored to individual personalities rather than having them the same for everyone. “The settings could evolve over time, instead of having one defensive technique,” he said. The research, though yet to be done, is one of the group’s goals in the near future. ▽

A VARIED LANDSCAPE OF HUMANITIES RESEARCH

A detailed history of OPEC, the complexities of land ownership in Kenya, and ethical positions of sonic practices and performance in Morocco — three areas of study being investigated by the first recipients of the NYU Abu Dhabi Humanities Research Fellowship Program— appear to be as far-ranging as it gets. In a way, this is precisely the point. The program was established with the aim to create a rich and varied research landscape for the humanities at NYUAD, and to help establish a vibrant intellectual community, fed by and invigorated by research.

“You could say the whole fellowship program is kind of a research laboratory,” said NYUAD’s Vice Provost for Intellectual and Cultural Outreach Reindert Falkenburg. “A laboratory in which each individual scholar pursues his or her own research goals, but as a whole, they are contributing to the intellectual landscape of our institution — shaping it, profiling it, and giving it areas of strength.”

The humanities include a range of academic disciplines that contemplate, study, and document the human experience; in addition to NYUAD’s main academic fields of philosophy, history, and literature, the humanities in the broader sense cross over into areas of the arts and social sciences. The program, led by Falkenburg and Lauren Benton, dean of the Graduate School of Arts and Science of NYU New York, is designed to both complement existing areas of research and create new ones by integrating scholars with a strong interest in the region and specific thematic research interests into the NYUAD community.

The program aims to build research capacity in areas of the humanities that are relevant for the study of the Arab world — its rich intellectual, religious, and scientific history; its cultural and artistic heritage; and its interaction with other cultures.

The fellowship program annually includes one or two senior fellows who are well-established in the international academic community and experts in their respective fields. “These are people who are able to act as a pivot for groups of other scholars and professors, who can establish small centers of research in certain areas that NYUAD can become known for throughout the world,” Falkenburg explained.

The first senior fellow appointed in the spring of 2014, Giuliano Garavini from the University of Padua in Italy, is one such academic. Author of the book *After Empires: European Integration, Decolonization, and the Challenge from the Global South 1957-1985*, Garavini is now at NYUAD writing a comprehensive history of OPEC from its inception to the present day.

There will also be up to four junior fellowships available each year for recent Ph.D. graduates, who will focus on researching and writing their first book, often based on their doctoral dissertation. The fellowship period is dependent on the individual scholar and may range from one semester to two years. Fellowships will also be available to Ph.D. students from NYUNY to complete dissertations that thematically relate to the Arab world, its culture, history, and literature.



Humanities Research Fellows: Reynolds Richter, Giuliano Garavini, and Anna Reidy discuss the progress of their research during a workshop in Abu Dhabi in April 2014.

Two doctoral candidates at NYUNY are currently conducting research for their dissertations as the first junior fellows in the program. Anna Reidy is completing her dissertation “Sound of Heart, Sound of Suffering: An Historical Ethnography of Ethics, Acoustics and Civic Life in Modern Tangier,” which examines the relationship between sonic practices of ethical self-cultivation — such as vocal prayer, sound-cataloging, or musical listening —and civic deliberation. Reynolds Richter is examining the complicated practices of claiming land ownership in coastal Kenya as they evolved from colonial to post-colonial times — practices that are based on native traditions of customary law but at the same time are exposed to the demands of Islamic or Western legal systems.

Active involvement with NYUAD and local and regional academic communities is an important component of the program. Along with NYUAD faculty, UAE scholars, and other invited speakers, the fellows participate in humanities research seminars, where their work is discussed critically.

“We hope to attract scholars that are not just conducting their research and writing their books and articles in a productive fashion, but those who are open to actively engage with the wider academic community at NYUAD,” Falkenburg emphasized. “When I think of what we are trying to build, I imagine a landscape in which our fellows help to carve out striking silhouettes of mountains and hills in the horizon of NYUAD’s future research.” ▀

NYUAD'S HUB OF ADVANCED GENOMIC AND BIOLOGICAL RESEARCH

Whether researchers at NYUAD's Center for Genomics and Systems Biology (CGSB) are conducting drug screening in nematodes, studying neurons in fruit flies, analyzing the genetic development of date palms, or investigating the use of algae as a source of biofuel, the fundamentals of the science are the same. "We all use the technique of DNA and RNA sequencing, or deep sequencing, to address questions that are important to each of us," said NYU New York Silver Professor of Biology Claude Desplan.

"The Center is a way of creating connections across disciplines," said Fabio Piano, NYUAD provost and founding director of CGSB in New York. "It's a catalyst and hub of activity that brings to bear all the parts of the university on some important questions. And that kind of collaboration has proven to be really powerful."

The Genetic Diversity of the Date Palm

For the past decade, Michael Purugganan has studied the evolution and diversity of crops by analyzing their genomes. He has worked on grass species such as rice and corn, but recently he has taken on the date palm, the iconic crop of the UAE and the region.

Purugganan, who is NYUNY Dorothy Schiff Professor of Genomics and professor of Biology, was intrigued by the date palm because little work had been done on its evolution and cultivation. And with the 100 Dates! Project he leads at NYUAD, he hopes that genetic analysis will "tell us something about the history of the date palm: when people started to cultivate them, and how they spread from North Africa all the way to the Indian subcontinent."

Date palms are extremely diverse; thousands of varieties are scattered from Morocco to Pakistan. Some varieties produce fruit that is extremely sweet; others have fruit that is quite bitter. Dates can range from yellow to nearly black. Some date palms can

survive on water with high salt content; others are resistant to disease.

"We're trying to understand the genetic basis for this variation, because that will tell us something about the history of the species and how it is evolving," Purugganan said.

Understanding the genetic mutations that help some date palms survive under difficult conditions could also help to improve cultivation. "We're finding that the water in many parts of the region is becoming more salty. So we're trying to understand how to cultivate date palms under increasing salinity levels," he said.

Not all of the work happens in the laboratory. Purugganan and members of his team try to glean information about varieties by speaking with farmers and vendors at markets in the region. Traditional knowledge can enhance the project, but it can also be confounding. For instance, just about every country has a variety called medjool. But is the UAE's medjool genetically the same as the medjool of Iraq? Testing in the lab can easily answer this question.

Unlike corn and rice, Purugganan does not expect that his team will find a common wild ancestor of cultivated date palms. Therefore researchers will need to be more "creative" when analyzing genetic data. But with a large enough sample, the team will be able to determine the historical and genetic



relationships among varieties.

Working in the UAE has provided benefits for Purugganan and his team: "We have partners in the UAE who are working closely with us to get samples from the emirates, and we have developed partnerships with people who have provided us with samples from Tunisia all the way to Pakistan."

Neuronal Specificity

A brain — even that of a tiny fruit fly — contains many kinds of neurons, with different physiological functions. Motor neurons can extend from the brain all the way to an appendage; other neurons can be localized to a small region of the brain. What accounts for this differentiation? Why do some cells become motor neurons, while others become visual neurons? And how do they end up looking so different?

Claude Desplan and his team of researchers at CGSB study the way neurons develop specificity. They are trying to figure out how visual neurons differ genetically from other neurons in the fruit fly brain. "All neurons, of course, share the same genetic information as other cells in the fruit fly, but not every cell expresses all of the genes," Desplan said.

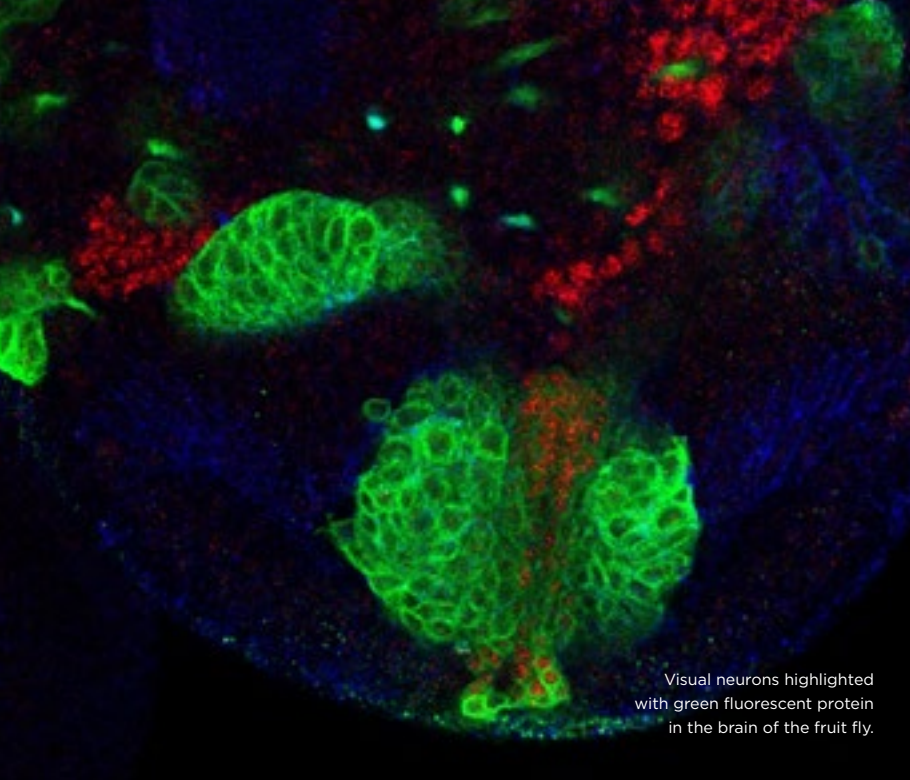
Transcription factors play a critical role in specifying the fate of cells in the fruit fly brain. But Desplan and his team are trying to figure out just how this happens. (Transcription factors are proteins that attach to DNA and influence the transcription of DNA to messenger RNA, a process that is responsible for the expression of a gene.)

In other words, these researchers in Abu Dhabi are trying to correlate the characteristics of neurons with the genes they express.

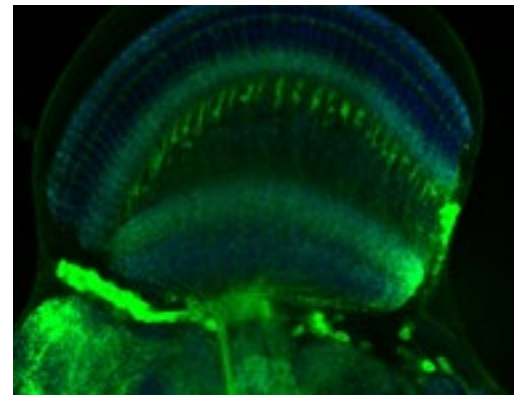
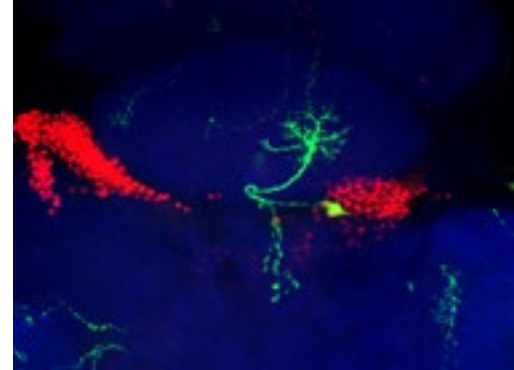
Researchers begin by modifying the fruit fly so that visual neurons in the brain express Green Fluorescent Protein (GFP). Under a microscope, these neurons can be distinguished from other brain neurons.

Researchers then use old-fashioned dissection of the flies' brains, and put the brain cells into a machine that separates the visual neurons that express the GFP from other neurons. "Once you have a few thousand of the cells that express the GFP, you can use modern technology for RNA sequencing, where you can sequence what genes are expressed in those specific cells," Desplan explained.

RNA sequencing provides researchers with a "total profile of gene expression" in the visual



Visual neurons highlighted with green fluorescent protein in the brain of the fruit fly.



neurons, and allows them to learn every gene that is expressed in those cells in a very precise manner, Desplan said. “There will be some genes that are expressed in every cell, but there will be other genes that are expressed only in certain kinds of cells.” Understanding the correlation between genes expressed specifically in one cell type and the properties of this cell type is important for understanding how cells gain their specificity.

Scale is important. “If you can get the RNA expression profile for 50 or 60 neuron cell types, you will be able to make correlations between the gene and the characteristic of the neuron, which might help you understand the rules of the game,” Desplan explained.

And understanding the rules of the game may provide Desplan and his team with insights about how specificity is achieved by cells in the fly brain, and perhaps in other cells, too.

Algae as a source of biofuel

Associate Professor of Biology Kourosh Salehi-Ashtiani’s group studies genetic development in algae, with an eye to using algae as a source of biofuel. “One major motivation behind this project is to see the relationship between environment and evolution,” he said.

The group analyzes terrestrial and marine algae,

including strains from New York and the UAE. Algae that accumulate or secrete a lot of lipids could be useful as sources of biofuel, and the researchers have already found a marine algae that is doing just that.

The algae from New York and Abu Dhabi share similarities genetically, but they are quite different in their environmental requirements. The Abu Dhabi algae is limited in the kinds of nitrogen compounds it can utilize for nitrogen assimilation (the process by which algae convert nitrogen from the environment into useful compounds, such as amino acids). This makes sense, Salehi-Ashtiani said: “The soil here in Abu Dhabi is not very rich in nitrogen. So over time, these algae might have lost some of the genes or abilities to use nitrogen sources that they never see.”

In addition to studying algae found in the environment, the team analyzes a model algae system, *Chlamydomonas reinhardtii*, which is interesting because it has genes that are plant-specific and others that are animal-specific. This encouraged Salehi-Ashtiani and his team to ask if these genes work together or separately, in other words, do these genes behave according to their evolutionary trajectories or are they transparent to that. The researchers discovered that if they removed one gene computationally from the organism, the deletion had little effect on development. But if you take out one

gene and another related gene, the modification has a great effect. This leads Salehi-Ashtiani to think that there is synergy involved.

“When we look at the metabolic network topology, or the genes’ placement on the network, as a subgroup, they are closer to each other. But when we look at other kinds of interaction, they are further apart,” he explained. “So over the course of evolution, the network has evolved such that for related functions they make use of proteins that have different phylogenetic affinities. *Chlamydomonas* seem to ‘like’ diversity, when it comes to genes performing similar tasks.”

Salehi-Ashtiani says that if you want to use algae as a source of biofuel, you want it to be able to grow well in the environment where it will be produced. The Abu Dhabi algae they have studied has a high heat tolerance, at least five degrees above that of the New York algae. It also helps if the algae grows fast and can withstand contamination from other algae or bacteria.

The algae should also produce lots of lipids. “Our soil algae usually don’t produce a lot of lipids, but they do grow fast, and you can induce them to make lipids if you starve them of nitrogen,” Salehi-Ashtiani explained. “But pretty much all of our marine algae make a lot of oil. And we are working on finding conditions under which they can grow quickly.”

Advanced Drug Screening

CGSB Founding Director Fabio Piano works alongside Kris Gunsalus, the program director for the chemical genomics group at CGSB. The group works with a model system called *C. elegans*, a nematode, or roundworm.

C. elegans are tiny — a millimeter long — and are excellent for genetic work because they have a lifecycle of less than three days, which allows researchers to study how the organism changes from generation to generation. They are also accommodating. “They feed happily on bacteria, and you can grow thousands, if not millions, in a lab,” Piano said. And their clear skin makes it easy for researchers to observe every cell in the animal with a microscope.

At NYUAD, Gunsalus’ team has built a lab specifically designed for studying *C. elegans* as

a model system for drug screening. Thousands of worms are grown on 96-well plates. A robot handles the plates and photographs the worms at different stages of development. The robot can also algorithmically analyze the images.

To date, the lab has produced several million images of the *C. elegans* under a variety of conditions and at different stages of maturity. “The system has a quantitative ability to tell us how many objects of a particular kind it sees in a huge set of images. And it can do this very quickly,” Gunsalus explained. “For instance, if I’m testing for a drug that kills *C. elegans* embryos, I’m looking for images of embryos that don’t hatch after a drug has been applied to them. And I can tell the system to look for specific shapes that look like un-hatched embryos.”

Humans and *C. elegans* have the same insulin pathways. “So you can use mutations in the worms that mimic the kinds of problems that would be present in a human who didn’t have insulin receptors,” Gunsalus said. “We can then test drugs or drug combinations that could cure the worm of this defect.” Those drugs might in turn be useful in finding new drugs that could be used to treat humans who have diabetes.

And though *C. elegans* are harmless to humans, their nematode cousins in the real world cause diseases that affect over a billion people. With their platform, the team will be able to screen drugs that could potentially treat diseases — like elephantiasis and river blindness — caused by other nematodes.

Technology and Society

Genetic technology is developing rapidly. A human genome can now be sequenced in a couple days for a few thousand dollars. This diffusion of once very expensive technology can help people to get a better understanding of their diseases or the diseases of their children, Piano said. But just because you can sequence a genome does not mean you should. “There are a whole bunch of other questions that society will have to deal with,” he said. “So now the question becomes: ‘In what circumstances do you sequence a human genome? What kind of information is it going to give you?’” ▀

DIVERSIFYING LINGUISTIC THEORY



The MEG system records brain activity on a millisecond basis to provide insight into the way the brain processes language.

The presence of a world-class neurolinguistic laboratory based in Abu Dhabi has an important significance for the field of linguistics; it means evidence-based research in a field currently dominated by English and other Western languages will increasingly be more inclusive of different, and often under-represented, languages.

For NYU Abu Dhabi's Neuroscience of Language Lab, which uses a sophisticated magnetoencephalography (MEG) machine to study the brain activity of subjects in response to specifically designed experiments, contributing to the body of knowledge in the field of linguistics means not only furthering existing theory, but also understanding and studying this theory in a more globalized context.

The team of professors, postdoctoral associates, research assistants, and visiting NYU New York Ph.D. students working in the lab are concurrently investigating a number of research areas. One significant research endeavor is focused on understanding the way the brain stores and accesses

individual words and how this process is affected by different properties such as frequency and context of use (for example, if a word functions as a noun or a verb).

In a study of complex and compound words that can be separated into parts (such as verbs followed by the gerund suffix -ing), the team has designed experiments to see if brain activity indicates that individual units are stored and then combined, or if these multi-part words are stored in the brain as a single unit.

In other research areas, the opportunity to review brain responses among subjects who are bilingual in English and Arabic has presented unique insights into the similarities and differences of how the brain comprehends and processes these two languages, and also how two languages co-exist in the brain. Differences in the structures of the languages themselves, like the way Arabic intertwines components to create complex words while English uses suffixes and prefixes with a base word, create interesting questions on whether these different structures require different underlying neurological processes.

The study of bilingualism itself is another important area of investigation. Postdoctoral Associate Stephen Politzer-Ahles explained: "How are the two languages represented in the brain? Are the English and Arabic words in the same area and are they competing with each other, or do you have English over here and Arabic over there?"

The value of studying different languages in developing linguistic theory can also play an important role in offering a more complete and comprehensive data set for the interpretation of research findings.

"We could do all this research in English and conclude 'this is the part of the brain that does this aspect of language,'" Politzer-Ahles said. "But if it turns out that really, the place of a word in that sentence [in English] is highly predictable, it might be that rather than being a 'language' part of the brain, the response relates to a 'prediction' part of the brain. This is why it's valuable to look at different languages." ▾

Thinking Arabic at NYUAD's Neuroscience of Language Lab

Meera Al Kaabi is a fifth-year Ph.D. student in linguistics at NYU New York, but her path to a doctoral degree started in the UAE where she has returned to conduct research on Emirati Arabic speakers at NYU Abu Dhabi's Neuroscience of Language Lab.

Al Kaabi studies the way human language is processed and represented in the brain. "In my case, I look at Arabic, a language where words display a different structure than in languages like English. While a complex word in English is made of a base and one or more suffixes or prefixes (called morphemes in linguistics), the constituents of a complex word in Arabic are typically intertwined with each other in a way that makes it impossible to isolate them as discrete units," she explained.

"This is the first time this kind of experimental paradigm has been applied to Arabic," Al Kaabi said.

She is now writing her dissertation and said that she is particularly attracted to the field of neurolinguistics because it provides a fascinating and important source of data that can be used to support or refute theoretical models. "There have been many debates in the field of linguistics, and neurolinguistic research provides insight into many lingering theoretical questions. This type of research offers a different perspective on language, and an interesting one."



MOBILE TECHNOLOGY FOR THE DEVELOPING WORLD

From better prices for their crops to disease prevention, the world's rural poor are beginning to harvest a rich crop of benefits from cell phone technology — and NYU Abu Dhabi researchers are helping to lead the way.

NYUAD's Center for Technology and Economic Development (CTED), under the direction of Professor Yaw Nyarko, is working to improve, employ, and encourage mobile phone uses and applications that go far beyond mere voice calls and email.

"We're interested in human-capital models of economic growth," said Nyarko, a Ghanaian-born professor of Economics, founder of Africa House at NYU New York, and co-founder of NYU's Development Research Institute.

"Technology, and especially mobile phone tools, are going to be extremely important" in economic development in poor regions, Nyarko said, and that is where CTED is focused.

In upcountry Ghana, for example, CTED is helping small farmers use cell phone GPS technology to ascertain the exact boundaries of their fields. This promotes efficiency — what's the point of weeding your neighbor's land, or buying more fertilizer than you need? — and helps to avoid property-line disputes. Field agents of Ghana's Ministry of Food and Agriculture "love that app," Nyarko said.

In Pakistan, meanwhile, phones are giving rural people a new way to fight dengue fever, a deadly mosquito-borne viral infection. Any time villagers

detect a case they call an official number. The calls are geo-located, so public health experts can pinpoint outbreaks and launch localized preventive measures. Pakistan's health ministry is working with CTED in applying this system, Nyarko said.

Nyarko mentioned other current and potential uses of cell phone technology. For instance, easy communication of up-to-date crop information —

yams are fetching 10 percent more today in town A than in village B — is increasingly available through informal producers' networks, in part due to CTED's work.

Then there is election fairness. Local people can now text-message the count from each ballot box to other districts,

making it harder for anyone to tamper with the voting papers after that initial count.

And this is only the beginning. The M-pesa system that started in Kenya makes prepaid mobile-phone minutes a kind of currency, easily swapped from one account to another.

"M-pesa is now a form of banking," Nyarko noted with satisfaction. "It's hard to find banks in rural regions, and you can't have automatic teller machines where there's no reliable electricity. But with SMS text messaging, here is a bank, out of





nowhere! It becomes a currency economy, with phone minutes as the currency.”

Of course mobile phones, too, need power, but an ingenious solution to that problem has sprung up, Nyarko explained, in Ghana and elsewhere: “There are people who will take a car battery into a village, and for a small fee let people recharge their phones from it.”

All in all, cell phone technology, making wired telephony unnecessary in areas where it is unavailable, holds increasing promise of better conditions for rural populations. CTED’s role in this process is to encourage, evaluate, and disseminate innovations. It’s a big task and one that is just starting.

“We have so many ideas,” Nyarko said. “We run out and try to do them in the communities.” After not quite three years of operations, CTED has a lot of projects under way. “Most of these things haven’t really come to fruition yet,” Nyarko said. “Right now we’re in scale-up mode. Maybe we’ll have some start-

ups soon.” But CTED is in the process of becoming a robust research entity.

CTED has established a research center at NYU’s Accra Campus, as well as local offices known as town halls in two rural agricultural districts in Ghana. They are also working with the Ethiopian Commodities Exchange (ECX) to study the impact of the exchange’s introduction in Ethiopia. This research will be of importance in Ghana as the ECX is the technical and management advisor of the Ghanaian government in the implementation of their commodities exchange. In the town halls in Ghana, Nyarko said, “we are getting to know the people. They like it that we are actually listening to them.”

Nyarko’s fellow faculty members are Lakshminarayanan Subramanian, an associate professor at NYU’s Courant Institute of Mathematical Sciences, and Jay Chen, assistant professor of Computer Science at NYUAD. They work with about 10 doctoral students and half a dozen postdoctoral researchers and software



LEFT: Recording multimedia with an app to help gather data on rural farms in Ghana. **ABOVE:** Conducting a training session on the use of mobile technology for data collection. CTED collaborated with local farmers to identify design challenges and incorporate feedback. Photos courtesy of CTED

engineers, some based in Abu Dhabi and some based in New York who also spend time in Abu Dhabi.

CTED’s work seems to be far from Nyarko’s roots as a theoretical economist, but he noted that theory and practice go together. “Behind the applied part is serious academic work. For example if we’re studying something with 1,000 farmers we have to randomize them, make sure we have both good and bad farmers in the sample, make sure it’s all correct in terms of how we get the data.”

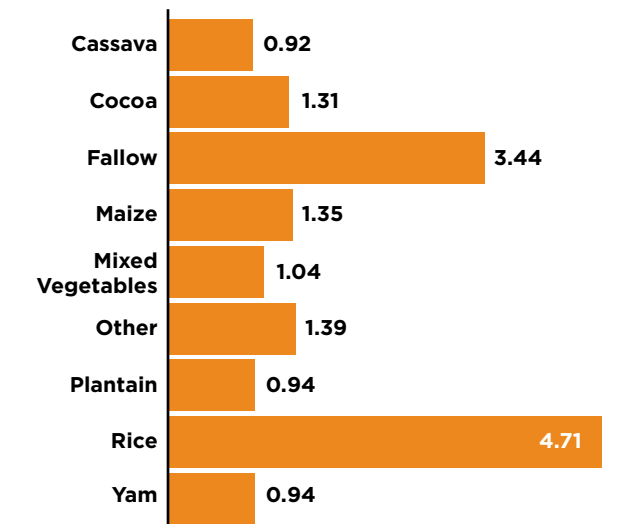
The practical applications, more than the theory, have won CTED favorable notice in Ghana: President John Dramani Mahama spoke at NYUNY in October 2013, as did Jerry John Rawlings, a former president, in 2012.

For all the rigor of his academic background, Nyarko said with evident satisfaction that CTED’s work is not only theoretical. “We have to write research papers, but we also think we’re doing some good in the lives of people.” ▾

Sample results from field test

201 maps were collected from Hohoe, a rural town of approximately 50,000 people in the Volta Region of eastern Ghana. The average time to map and mark observations around each farm took eight minutes.

Average acreage for various crop types



Source: CTED

MODELING FUTURE CLIMATE

Understanding our planet's climate, and how it is changing, is growing increasingly urgent. But the task is so enormously complex that today's best computer models are still insufficient, almost primitive. At NYU Abu Dhabi's Center for Prototype Climate Modeling (CPCM), mathematicians and scientists with several specialties are working together on the problem.

The Center's principal investigator is Andrew Majda, Samuel Morse Professor of Arts and Science at the Courant Institute of Mathematical Sciences at NYU New York; his co-principal investigators are Shafer Smith and Olivier Pauluis, both associate professors of Mathematics. They work with the Center's senior scientist Ajaya Ravindran and a growing number of postdoctoral associates.

Majda, Smith, and Pauluis, are based at the Center for Atmosphere Ocean Science (CAOS), part of the Courant Institute, while Ravindran is based in Abu Dhabi.

The CAOS and other institutions around the world are developing new mathematical theories to improve climate modeling. CPCM's role is to convert those pieces of theory into practical mathematical tools, and to demonstrate that these work in the real world. "In New York [at CAOS] we're thinking about the tools, and here in Abu Dhabi we're putting them together," Pauluis explained.

Mathematicians and scientists have been building climate models for a long time, but in recent decades the work has been increasingly dedicated to accurate predictions of climate change, as a basis for decisions by policy-makers.

But the globe's climate is so spectacularly complicated that despite all the advances in computing, "we still don't know very well what is the best way to represent climate and analyze data. We have to find the way to best represent the physics," Pauluis said.

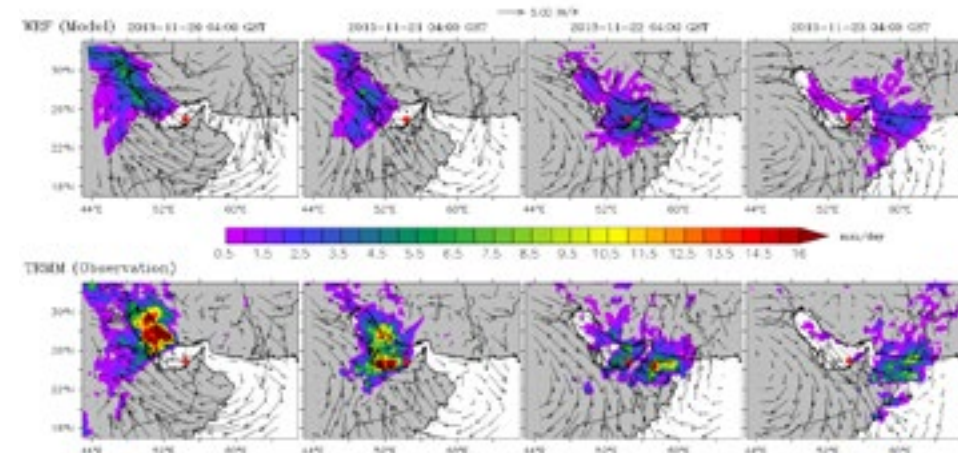
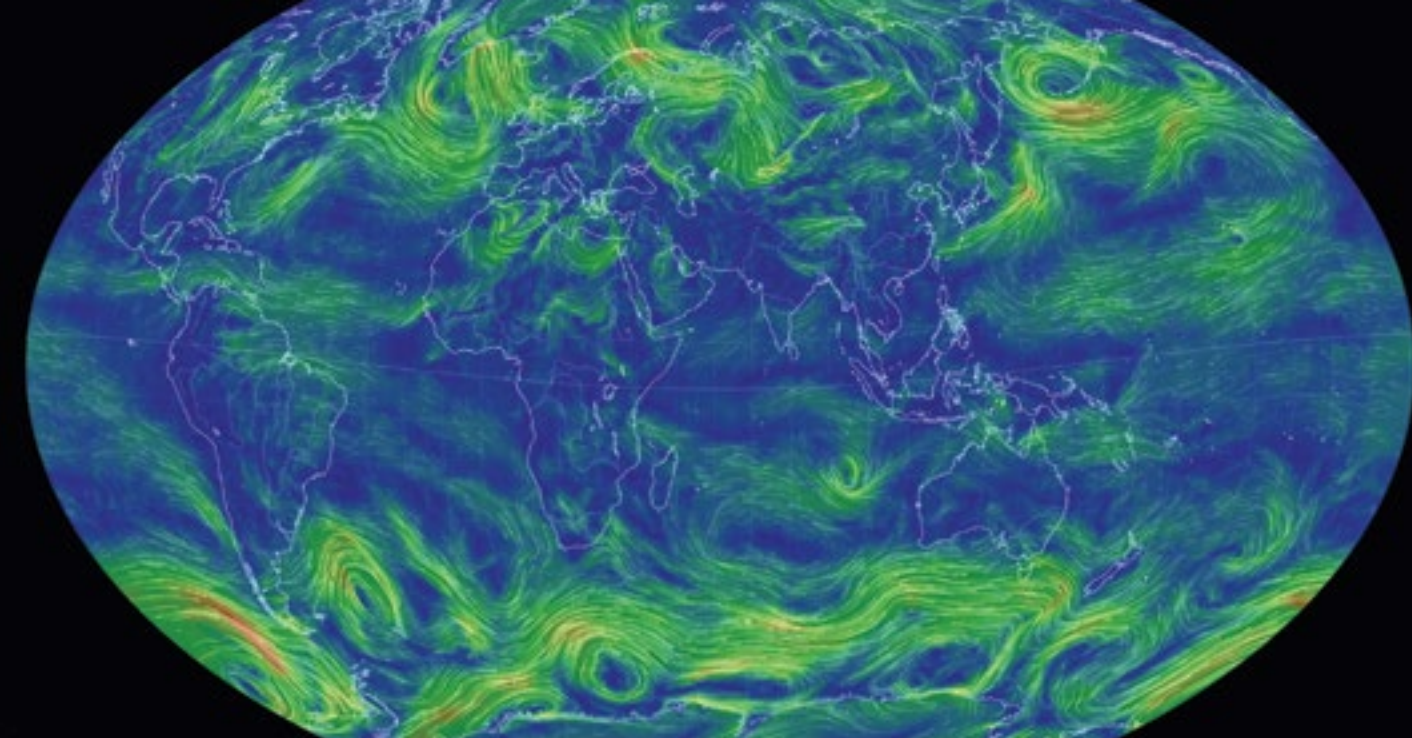
"The current approach tends to be too restrictive," he continued. "The tools we have don't reproduce the natural fluctuations we find in weather. So we're trying to put some randomness in the mathematical model. But the problem is to make the randomness accurate."

There are two sources of complexity in the global climate. One is related to the problem of turbulence in the dynamics of fluids, not only ocean water but air as well. "In a swimming pool, for example, you create simple turbulence where your own swimming motions generate a few small eddies. But on the scale of the weather, changes generate a lot of smaller motions" and these interact. "Trying to model this," he added, "you soon run out of computing power and computer time."

The people at the CPCM, he said, are "big users" of NYUAD's High Performance Computing Cluster. Yet, as admirable as that computer is, "it will probably take another century" before the world's scientists get the computing resources they need for this problem.

Meanwhile, additional complications arise because climate is more than just fluid dynamics. There are aspects of chemistry, biology, and more to consider, such as when plants convert carbon dioxide to oxygen. All in all, said Pauluis, "we're still in the process of identifying the equations we have to solve."

As an example of the Center's work, Pauluis cited a recent project on rain. "A huge amount of energy



TOP: A capture of a moving map of current wind currents provided by <http://earth.nullschool.net/about.html>. **LEFT:** A model of a November 2013 rain storm moving through the Gulf.

is dissipated in the atmosphere as rain falls, because friction with the air slows the raindrops." The CPCM has used satellite data to measure the amount of energy released this way. That's the kind of research that will make future climate models more robust and reliable than the current ones.

Pauluis, born in Canada but raised in Belgium and educated there before earning a Ph.D. at Princeton, focuses mainly on clouds. "This is very good for me, because on a nice day I can go outside and look at the clouds," he joked.

Clouds are in fact an important part of the climate change puzzle. "People tend to focus on warming, but one of the more drastic effects of that is what it will do to rainfall. The distortion of precipitation

patterns is one of the most difficult parts to forecast, but it's also one of the most important," he said.

And it is a topic of special interest in the Arabian Peninsula. "We believe that this region is going to warm faster than other areas," Pauluis noted, "and that the subtropics are going to get drier."

The pace of research on climate modeling can seem painfully slow, considering the urgency of the climate change issue. But there are no magical answers, Pauluis said, and unfortunately "there is a lack of urgency at the political level.

"Maybe my generation won't be able to do much about that," he continues, "but by teaching students, I hope we can help the next generation find the courage to do what must be done." ▀



WARMING IN ANTARCTICA TIED TO CHANGES IN THE ATLANTIC

Many of the world's big cities are built near the ocean. This means that rising sea level caused by climate change threatens the homes and livelihoods of millions of people who live along the coast. According to Professor David Holland, the main sources of water that will lead to elevated sea level are the melting ice sheets of Antarctica and Greenland.

In January 2014, Holland and a member of his team from the Center for Global Sea-level Change (CSLC) at NYU Abu Dhabi published a paper in *Nature* that found that one of the most sensitive and critical areas of the Earth's ice in West Antarctica is being affected by changes in the north and tropical Atlantic, which has been warming for over 30 years.

Climate change is truly a global phenomenon; changes in one part of the globe can influence climate in another, since ocean currents and winds link distant regions. But the team's conclusion is surprising because initially there is no reason to think that the far-off north and tropical Atlantic would affect Western Antarctica.

But this seems to be the case, and their analysis demonstrates the complexities of global climate, said Holland, who is professor of Mathematics and Atmosphere-Ocean Science at NYU New York and head of CSLC. The paper's lead author, Xichen Li, is a doctoral student at NYU's Courant Institute of Mathematical Sciences and affiliate of CSLC.

The future of rising sea level will in part be determined by the way the ocean interacts with large ice sheets like the one found in West Antarctica. These massive glaciers flow slowly over land and eventually meet the sea. Where ice sheets meet the ocean, the warm water speeds up the melting of the ice.

"To date, the focus of our work has been studying the melting of ice sheets on location by carrying out field programs in Antarctica and in Greenland," Holland said. But for the paper published in *Nature*, the researchers wanted to understand just how warm ocean water was being directed to West Antarctic glaciers in the first place.

They started with a problem.

Scientists have long known that the Antarctic Peninsula in West Antarctica is subject to climate change. Indeed, over the past few decades, the peninsula has warmed more than anywhere on the planet, and this warming has led to the melting of land-ice in the region. The sea-ice that surrounds the peninsula, however, has not necessarily declined, but has redistributed itself in odd ways.

Scientists have also known that the climate of this remote region — which lies about 600 miles south of Tierra del Fuego — is affected by changes in the Pacific Ocean, and that changes in the Pacific cause short-term changes to the climate of the peninsula. But fluctuations in the Pacific could not account for the warming of the peninsula or the redistribution of sea-ice around it. So, for this paper, researchers focused on the Atlantic, which had been overlooked as a force behind Antarctic climate change.

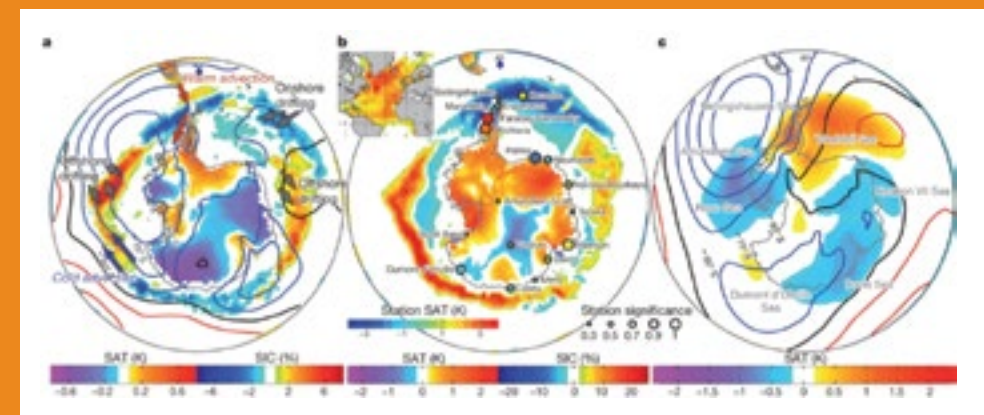
It is remarkable that the recent 30-year trend in North Atlantic Ocean warming is driving climate change in West Antarctica, Holland said. And it is worrying that "West Antarctica is precisely the

"WE ARE TRYING TO DEVELOP THE CAPABILITY TO PROJECT SEA-LEVEL CHANGE FOR THE NEXT CENTURY AND BEYOND"

most sensitive place on Earth for future sea-level change," he added. "This opens the possibility of significant sea-level change in the next century, which could have a huge impact on low-lying coastal areas."

Holland and his team plan to carry on with the work that was done for the recent paper and to expand on their findings: "We plan to do further climate modeling to help us better understand the connection between the north and tropical Atlantic and the waters off West Antarctica. Moreover, we are trying to develop the capability to project sea-level change for the next century and beyond."

Additional authors of the paper are Edwin Gerber, assistant professor at NYU's Courant Institute of Mathematical Sciences; and Changhyun Yoo, postdoctoral fellow at the Courant Institute. ▀



ABOVE AND BELOW: Professor David Holland conducting research and working with NYUAD students in Greenland. **LEFT:** A map showing the observed winter patterns in Antarctica related to tropical Atlantic Ocean warming.



LONG-TERM STUDY OF EMIRATI HEALTH

The UAE has one of the world's highest rates of diabetes, but the causes of this high rate of disease are not clear. Now NYU medical scholars are seeking the answer to that and other public health questions, through a long-term study of Emiratis' health.

The NYU Abu Dhabi Public Health Research Center (PHRC) plans to follow a sample of 20,000 UAE nationals in the country's first-ever "cohort" study. Researchers will periodically check in with the individuals over many years. Statistical assessment of longevity and health status, combined with information about behaviors and lifestyle practices, can help to pinpoint the causes of early death and serious illness.

Scott Sherman, an associate professor in NYU's departments of Population Health, Medicine, and Psychiatry, is one of four principal investigators on the project, now in the design stage.

"There are lots of hypotheses" about why 44 percent of Emirati adults have diabetes or the condition known as pre-diabetes, Sherman said, "but nobody has a good answer why. A cohort study will allow us to get at the factors."

Cohort studies are a well-established tool for identifying what contributes to a population's health situation. Sherman explained that the best-known project of this type, the Framingham (Mass.) Heart Study, "has made countless discoveries about cardio-vascular risk factors associated with different outcomes." That study began in 1948, he notes, and continues still; it will probably conclude only when all its subjects are dead.

So when Sherman and his colleagues tried to design a project for NYUAD that could contribute to better health outcomes for Emiratis, a cohort

study came to mind.

Sherman is working with Ann Marie Schmidt, Richard Hayes, and Ravichandran Ramasamy, all professors at the NYU School of Medicine. The project now also has an Abu Dhabi-based director, Raghieb Ali, a clinical epidemiologist at the University of Oxford.

The Abu Dhabi cohort study, to be conducted by the PHRC in conjunction with the PHRC's Diabetes Research Center, will focus on that disease and cardiovascular problems, also common among Emiratis.

Designing a cohort study is not simple, and roughly the first half of the initial grant period of five years is being devoted to organizing the work.

The first plan was to sign up 5,000 subjects — Emiratis only, because the transience of other UAE residents makes follow-up difficult — but that has now been expanded to an ambitious 20,000. Each will have a detailed initial interview and agree to provide samples of body fluids — blood, urine and saliva to establish the cohort's baseline data. A subset of the entire sample will undergo additional non-invasive testing, such as ultrasound imaging of carotid and arm arteries.

Subsequently, each subject will be contacted briefly every three months, and interviewed in detail every five years.

The four principal investigators and their team have worked out an initial questionnaire. Once a cohort study gets rolling, it is common for other

researchers to ask to add their own questions, on a range of subjects. The PHRC/DRC group has invited government agencies and other university experts to propose additional questions — road safety is often mentioned — but there is a practical limit to how many queries respondents can handle.

There is also a lot of "back office" planning being done now. For example, information technology specialists must design systems to collect and preserve all the initial data and subsequent updates. Laboratories must be available to process the blood samples.

Further, all human-subject studies must clear the hurdle of approval by research-ethics committees, known in the US as institutional review boards. These typically ask three questions: is the process beneficial to the individual; is the process and concept fair; are participants treated respectfully. This study has won NYU School of Medicine approval and is on its way through Abu Dhabi's equivalent process. It will then go under NYUAD review before recruiting can start.

The plan is to begin in summer 2014, recruiting the first 500 subjects in a pilot project to make sure the process works as designed, before it scales up to the full 20,000. The researchers plan to recruit participants through local clinics.

With these sources of participants, the planners will have to take care to make sure that the sample is representative. Another challenge is that because cohort studies are not as well known in the UAE as in the West, cultural factors may discourage participation.

Sherman and his colleagues hope to recruit some prominent Emiratis to take part, and to say so through publicity; he concedes that participation by nationals may be an issue.

For all the challenges, Sherman is encouraged by the progress made so far. Based in New York, he has made over a dozen trips to Abu Dhabi in the past two years.

All in all, Sherman said, "The people have been wonderful to work with and we think we can do really important research and contribute to improving the population's health." ▀

First international conference on waterpipe tobacco research

More than 100 physicians, academics, policy-makers, and public health advocates participated in the "First International Conference on Waterpipe Tobacco Research" that was held in October 2013 in Abu Dhabi.

"The talks synthesized existing knowledge on most aspects of waterpipe tobacco smoking, including epidemiology, addiction, health effects, economics and cessation. Participants collaboratively identified future research needs, as well as projects that they can work on in the short term," said Scott Sherman, principal investigator for the Public Health Research Center at the NYU Abu Dhabi Institute and associate professor of Medicine and Psychiatry at NYU Langone Medical Center.

Though there is a common perception that waterpipe smoking (also known as hookah, or shisha) is not harmful to users, the participants argued strongly that waterpipe smoking is just as harmful — if not more harmful — than smoking cigarettes. A major goal of participants of the conference is to correct this misperception.

The participants also recommended that "education, mass media, and other approaches should be harnessed immediately to communicate the dangers of waterpipe smoking, especially to deglamorize and correct misperceptions about the water filtration process." Many smokers believe that water acts as a filter to remove harmful toxins and particulates from waterpipe smoke. This is not the case.

The conference was sponsored by the NYU Abu Dhabi Institute, the International Development Research Centre, the Syria Center for Tobacco Studies, the NYU Abu Dhabi Public Health Research Center, and the American University of Beirut.

COMPUTATIONAL MODELING OF THE HUMAN BRAIN

“The human brain is an intriguing and complex system. Understanding it not only presents profound implications of our existence, it also provides an important endeavor for scientific and medical research,” said David Cai, principal investigator of NYU Abu Dhabi’s Computational Modeling of Normal and Abnormal Cortical Processing Project and professor of Mathematics and Neural Science at NYU’s Courant Institute.

The computational neuroscience research group at NYUAD headed by Cai has been developing theoretical and computational models of neuronal processing in the normal and abnormal brain to further our understanding of how our brain works in such states. To do so, understanding the relationship between functional connectivity and anatomical connectivity of the brain is vital. Functional connectivity, which can be measured by modern imaging tools such as EEG or fMRI, describes the statistical correlation and dependencies of different areas of the brain.

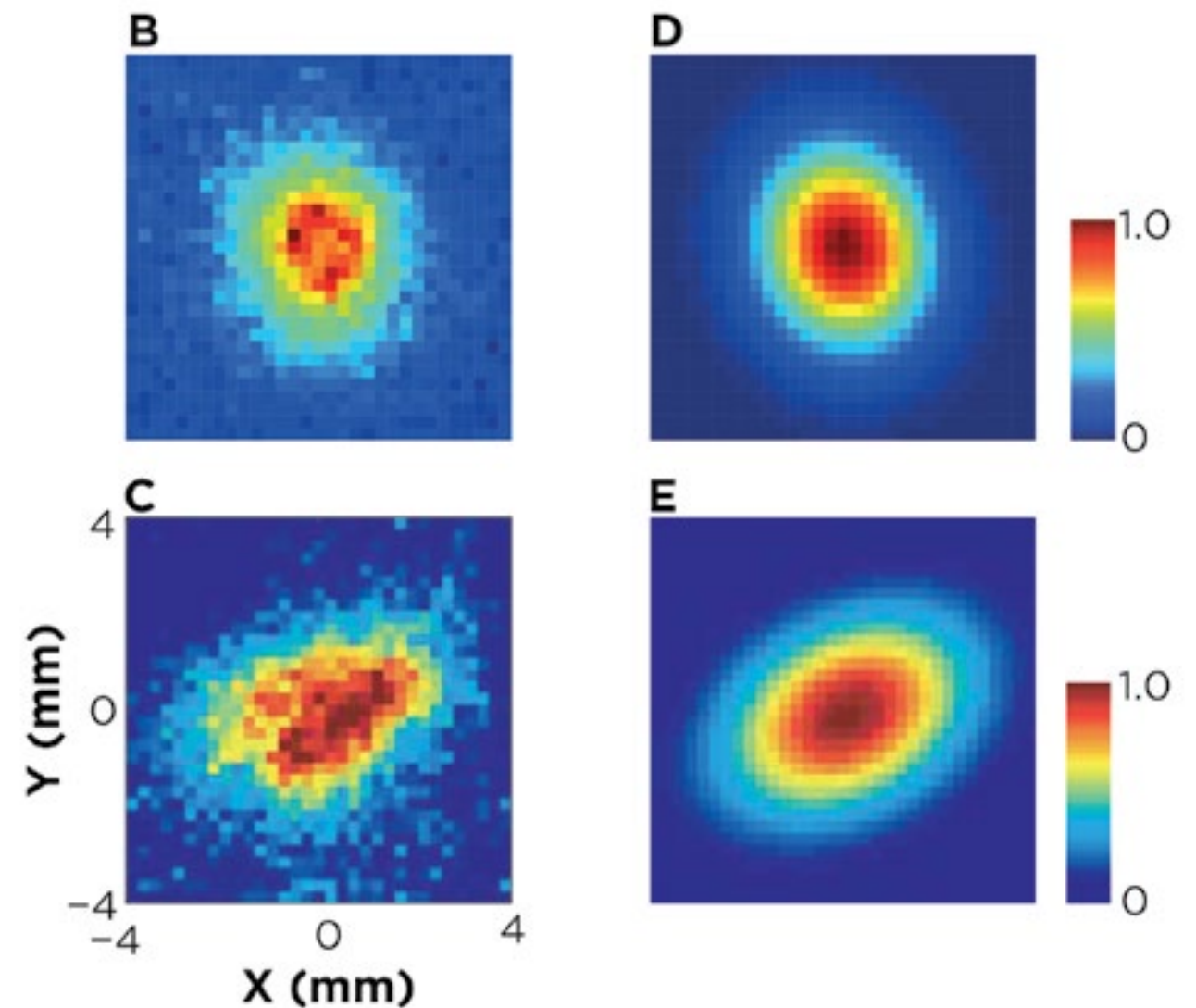
“We want to help answer the question ‘what do these statistical correlations mean structurally and dynamically?’” Cai said. The research team aims to study the underlying network structure of the brain observed through imaging techniques and find out if there is a strong causal relationship in addition to the statistical correlation between these connectivities.

The functional connectivity, causal connectivity, and structural connectivity are different manifestations of underlying dynamics between neurons. However proving causal connectivity is challenging; statistical methods to indicate causation, beyond establishing correlation, are limited. One such method, the Granger causality test, has been used to predict causality in time-sequenced events. However, has not been adequately assessed as a tool when applied to nonlinear dynamical systems, such as those in the brain. In 2013, the team published a paper to establish theoretical relationships between the various connectivity

and neurophysiological signals in *Physical Review Letters*. “Our research has demonstrated that the Granger causality approach can actually be very effective in understanding certain structural connectivity using neurophysiological data,” Cai explained.

New technologies such as multi-electrode recordings can provide extensive data by measuring electrophysiological signals in the brain; but with more than 100 electrodes used in this process, reading and analyzing the information embedded in the recording is a challenging and difficult task. To make this a more effective tool in exploring neural processing, the NYUAD research team is trying to devise new mathematical methods, combining insights from nonlinear network dynamics and high-dimensional statistics, to help reveal the information hidden in these recordings. “For neuroscience, it is extremely important to be able to read far more than 100 electrodes simultaneously,” Cai added.

In addition to improving the tools and methods for neuroscience research, the team has made significant progress in advancing theoretical knowledge on the visual cortex, with their findings published in the *Proceedings of National Academy of Sciences* in 2013. Using experimental results on the visual cortex as a basis, the team devised a theoretical computational model with greater opportunity for exploration. For example, in contrast to the traditional computational modeling of visual cortex that were usually limited to an anesthetized brain state of animals, Cai mentioned that “in some



sense, the new theoretical approaches suggested that the computational modeling is capable of tackling phenomena which can be associated with the awake state of the brain.”

“We are able to confirm certain observations and tell trustworthy data based on our mathematical analysis and network modeling of the dynamics of the visual cortex,” he added.

The research team will continue to build a large computational model of various areas of the brain to study the diverse phenomena and to extend their current findings.

With Cai’s lead, the research project aims to make computational approaches in neuroscience a truly powerful methodology capable of unifying invasive and noninvasive observations in both healthy and abnormal brain states. ▀



TOP: The spatiotemporal profile (B and D) of collective neuronal responses in the primary visual cortex, as observed in voltage-sensitive-dye based optical imaging experiments (C and E) in which monkeys performed visual detection tasks. **ABOVE:** David Cai, principal investigator of the project, in the classroom.



FACULTY RESEARCH HIGHLIGHTS

The sustained strength of research and scholarship at NYU Abu Dhabi lies in its outstanding faculty. Attracted to Abu Dhabi from around the world, the University's faculty are leaders in their disciplines and are committed to developing NYUAD into a leading world center of research, scholarship, and artistic creativity.





NANOPARTICLES FOR DELIVERY OF CANCER TREATMENT

A defining feature of NYU Abu Dhabi Assistant Professor of Chemistry Ali Trabolsi's office is the large whiteboard that looms on the wall. Decked in hexagons, subscripts, curt lines, and symbols, he uses this simple technology to illustrate the makeup of the complex chemical structures he and his team study at the University's Center for Science and Engineering.

At the Center, Trabolsi leads the Trabolsi Research Group, which focuses on supramolecular multifunctional systems: these are modified molecules developed by chemists for applications in a variety of fields, including medicine and engineering. In the past two years, the group has produced cutting-edge research that may help improve the effectiveness of drugs used for cancer treatment.

The group nurtures a collaborative approach that draws on the varied expertise of Trabolsi and the other researchers. Indeed, he describes his own training in chemistry as an amalgamation of several approaches. As a Ph.D. student he studied physical chemistry at the University of Strasbourg in France. Following his Ph.D., he focused on organic chemistry, host-guest chemistry, and supramolecular chemistry in positions at the University of California,



Los Angeles and Northwestern University in Evanston, Illinois. He joined NYUAD in August 2011, after working as a research scientist at King Abdullah University for Science and Technology in Thuwal, Saudi Arabia. “When I moved to NYUAD I decided to take a bit from all of my past experiences,” he said.

Trabolsi’s composite background, combined with those of his team, has produced important research. With NYUAD Postdoctoral Associate Farah Benyettou and NYUAD Assistant Professor of Practice of Biology Rana Al-Assah, he recently published a paper in the *Journal of Materials Chemistry B* that describes the creation of a composite nanoparticle that may potentially be used to treat cancer.

It is no coincidence that Benyettou and Trabolsi collaborated on this project. “When I started at NYUAD,” Trabolsi said, “I hired Farah, who is the main author of the article. I said, ‘Why don’t we

combine your expertise in iron-oxide nanoparticles and my expertise in supramolecular chemistry, and let’s come up with a new idea.’ And that’s exactly what we’ve done.”

Benyettou has studied iron-oxide nanoparticles for years: “She knows how to make them, she knows how to control their size, and she knows how to functionalize and characterize them,” Trabolsi explained.

Also trained in France, Benyettou studied physical chemistry before working toward a Ph.D. that focused on a new way to treat cancer with magnetic iron-oxide nanoparticles. In her first postdoctoral fellowship Benyettou learned many of the techniques she has applied at NYUAD.

For Benyettou the collaborative culture of the research group has been a boon: “When I joined this group, Ali let me do the research I wanted to do without any boundaries, without any limits.”

Benyettou, Trabolsi, and their colleagues began the

experiment with magnetic iron-oxide nanoparticles, like the ones Benyettou worked with on her Ph.D.. These particles – which look like liquid red iodine when mixed with water – hold great potential as nanomaterials in medicine because they are extremely small, non-toxic, and can be used as both imaging agents and for drug delivery. The researchers then attached a series of macrocycle “containers” to the iron-oxide nanoparticles (see *Illustration 1*). “By coupling a container to the surface, the new nanoparticles can be used for a dual application: for MRI and also to deliver an anti-cancer drug” Benyettou said. This is called a theranostic system, in that it would allow physicians to monitor and control the distribution of drugs in a patient.

In this initial experiment, the authors opted not to deliver a drug, but to test the delivery of a dye to prove the success of their idea. The dye, called Nile Red, is not fluorescent on its own, but when the dye is added to the macrocycle container, it becomes fluorescent. This fluorescence allows researchers to track the nanoparticle throughout cells (see *Illustration 2*, which shows the particle within the cell).

Moreover, the dual action makes it possible for the nanoparticle to be used not only for MRI but also for treating cancers locally, as they are magnetic and physicians could potentially control the location and distribution of the particles. This would have positive application in chemotherapy cancer treatments.

“The nanoparticles can be guided with a magnet and thus can be localized in a particular part of the body. This may help reduce the side effects of cancer drugs,” Benyettou explained. “That’s the problem with chemotherapy: when you administer the drug it goes everywhere; it kills cancer cells, but it also kills healthy cells.” By controlling the distribution of cancer treatment chemicals in the body, this new development may also help prevent damage that is caused to healthy cells.

What comes next? Benyettou and Trabolsi have written a proposal to add a popular cancer drug to the nanoparticle to see how this modification affects cancer cells in living tissue. They are also working on a variety of techniques for controlling the release of the drug from the macrocycle (see *Illustration 3*). ▀

ILLUSTRATION 1

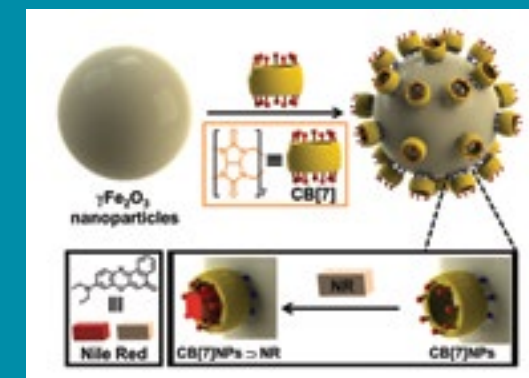


ILLUSTRATION 2

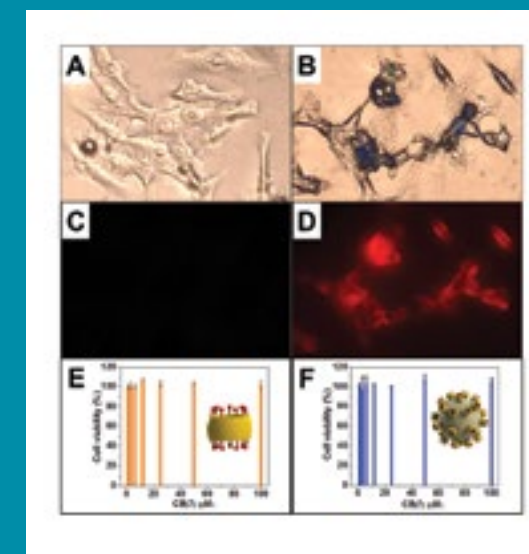
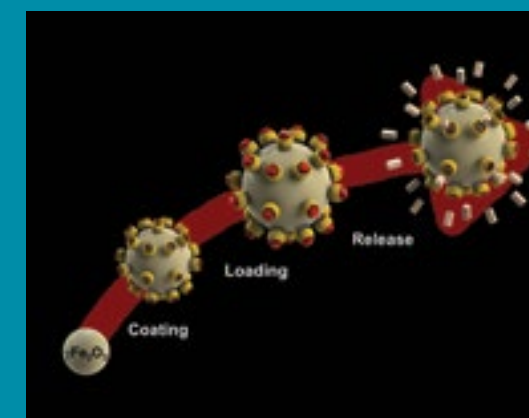


ILLUSTRATION 3



OPPOSITE PAGE: NYUAD Assistant Professor of Chemistry Ali Trabolsi, left, and NYUAD Postdoctoral Associate Farah Benyettou, right, published a paper in August 2013 that describes the creation of a composite nanoparticle that may potentially be used to treat cancer.

ANALYZING GENDER IMBALANCE IN WIKIPEDIA

Hannah Brückner, associate dean of Social Science and professor of Social Research and Public Policy at NYU Abu Dhabi, is using her experience studying gender inequality to investigate a relatively new phenomenon and field of knowledge – Wikipedia.

Chances are you've used Wikipedia before. The free encyclopedia that anyone can edit is one of the most popular resources on the web. In 2014, the English-language Wikipedia contained a mind-boggling 4,415,919 articles. The site's linguistic breadth is impressive, too. Pages are written in more than 280 languages, from Afrikaans to Zulu. There are even nearly 200,000 articles written in Esperanto, the world's most popular "constructed" language.

As Wikipedia has become the de facto web reference, Brückner thinks it is important to ask: How does gender influence the creation of Wikipedia pages? Specifically, she is interested in the way gender bias affects the development of pages for American academics in the fields of computer science, history, and sociology, disciplines that vary in their gender composition. Brückner is working jointly with Yale University Professor Julia Adams, and their project – "Collaborative Research: Wikipedia and the Democratization of Academic Knowledge" – is being funded by a grant from the US National Science Foundation.

Unlike a traditional encyclopedia that is produced by a team of professional writers and editors, Wikipedia is the product of many volunteers. New entries are proposed by members of the Wikipedia community; administrators have the option to challenge a page if the page doesn't meet certain criteria. If the argument for the page's existence is deemed insufficient, the page is deleted. This system may offer great opportunity for the democratization of knowledge. But it also presents risks.

For instance, 80 percent of academics listed on the Wikipedia page American Sociologists are male, while in reality less than 60 percent of American sociologists are male. "It could be that male sociologists are simply better scholars and are more deserving of Wikipedia pages than are female sociologists," Brückner said with a wry smile. "Or it could be that there is a systematic misrepresentation

of female academics on the site."

Brückner's team will start their investigation by utilizing the site's own guidelines. According to Wikipedia, for an academic to have a page, that academic must pass "the professor test." That is, the scholar must hold a named chair, or be the editor of a top journal, or have "made substantial impact outside academia in their academic capacity," for example.

The researchers will use "the professor test" to create a list of academics in each field who are "at risk" to have a Wikipedia page. "We will have a list of people who our model predicts should have a page on Wikipedia and don't, and also a list of people who our model predicts should not have a page on Wikipedia but do," Brückner explained.

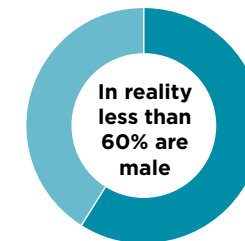
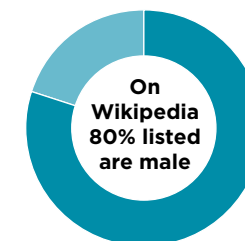
Further, by utilizing Wikipedia's application programming interface (API), which can provide vast amounts of data about the editorial history of every article, Brückner and her team will analyze article content, length, revision history, and the number of editors who have been involved in the maintenance of articles. They will also analyze the way each article is integrated into the fabric of Wikipedia, by examining the links that connect an article to the rest of the site.

Once this phase of research is complete, other avenues for further inquiry will open. Brückner also mentioned how she is fascinated by the way policies and processes vary for Wikipedias in different languages: the German Wikipedia, for example, is more restrictive and has more quality-control policies than does the English-language Wikipedia.

This difference has pushed Brückner to think about future research projects: "Here at NYU Abu Dhabi there are many students who speak languages that I don't speak. I'd love to teach a research practicum in which I'd work with undergraduates to explore the question of how Wikipedia is produced in many different languages." ▀

American Sociologists listed on Wikipedia, and the number of sociology faculty

■ Male ■ Female





PERSONAL HISTORY IN IMAGE AND ARTIFACT

Tarek Al-Ghoussein's latest creative work, a mixed-media presentation called *K Files*, is the autobiographical product of his unusual personal history: a Kuwaiti of Palestinian origin, he grew up largely in New York, Washington, DC, and Tokyo, and studied at NYU New York and in New Mexico. Before coming to NYU Abu Dhabi, he worked in Jordan, Cairo, and Sharjah.

An artist and professor of Visual Art at NYU Abu Dhabi, Al-Ghoussein has created and assembled, *K Files*, an exhibition following his personal and family history by means of self-portraits and media artifacts relating to his family. The work has been seen in Dubai and is booked for New York.

Tarek's father, Talat Al-Ghoussein, was Kuwait's ambassador to the United States and the United Nations. In a family album at his parents' house, Tarek found newspaper clippings about them. A *Buenos Aires Herald* piece, almost 50 years old, shows Jacqueline Kennedy thanking Talat for a donation to her late husband's library: "Expressing her deep appreciation, Mrs. Kennedy requested the



THIS PAGE AND PREVIOUS PAGE: Self-portraits in Kuwait from artist and NYUAD Professor of Visual Art Tarek Al-Ghoussein's *K Files*, an exhibition following his personal and family history. Al-Ghoussein's father was a Kuwaiti ambassador to the US and the United Nations.

Ambassador to convey her thanks to the government and people of the State of Kuwait.”

Another, from a 1965 *Miami Herald*, compares Kuwait to a West Texas boom town, and says “Ambassador and Mrs. Talat Al-Ghoussein give amusing dinners and dancing parties” at their home in Washington, DC. In *K Files*, the album pages with these clippings have been blown up to hang on the gallery wall.

Al-Ghoussein found some of the original newspaper photos for sale online. “It was strange to find these pieces of my past on sale on eBay,” he said. For USD 6.69, for example, he bought one showing his parents with the wife of Jordan’s ambassador to the US. Al-Ghoussein chose not to unwrap these photos; their Aramex and US Postal Service envelopes, unopened, are displayed in a glass case.

The other part of *K Files* consists of 60-by-90 centimeters “performative” self-portraits Al-Ghoussein took last year in Kuwait, each showing an inconspicuous figure, dressed in black. One shows him in a reception site for state visitors; another

where the British first drilled for oil; another in a high school. The young Al-Ghoussein lived in Kuwait for only three years, but remembers these locations.

What unites the elements of *K Files* is that “they are about a process of tracking” both personal history and historical developments in Kuwait, Al-Ghoussein explained. They also share visual elements: a painting of the first emir of Kuwait, seen in the background of a photo of his parents, also appears in a self-portrait Al-Ghoussein made at the Kuwaiti stock exchange.

Last year, he was invited by the Kuwaiti government to represent that country at the Venice Biennale. “It was nice to make a body of work in Kuwait,” he said. “It was the first time I had done so.” “It’s true I am a Kuwaiti national, but I haven’t lived there for 30 years. So it was a surprise to be asked.”

His book, *Transfigurations: Photographs of Tarek Al-Ghoussein*, will be published in September 2014, by the British house Blackdog. Publication will coincide with a showing of *K Files* at New York’s Taymour Grahne gallery.



Al-Ghoussein’s path to *K Files* has not been direct. He studied photography as an undergraduate at NYU in New York and earned a Master of Fine Arts in photography from the University of New Mexico. He then spent a year shooting in a Palestinian refugee camp in Jordan. “I made some so-called ‘good pictures’,” he said, but documentary photography “wasn’t communicating what I wanted to deal with” — namely the refugees’ sense of feeling uprooted. “I would show work to people in London, and they would say, ‘Look, they’re not that poor, they have TVs.’ And I’d say, ‘Well, economic hardship is only one of the issues they encounter. The bigger problem is not having a homeland.’”

He moved to Egypt and taught for a year at the American University of Cairo. Then the Gulf War started in 1990. It was a time for re-assessment: Al-Ghoussein decided to step away from photography, and found work as a desert guide and dive master in Egypt’s Sinai. He did not take a photograph for four years. “In a sense I just wanted to forget what I had learned in graduate school,” he said.

But seeing a photo exhibition at the Victoria and Albert Museum, in London, left him “a bit nostalgic.” So he submitted a hastily-assembled portfolio to the museum’s photography curator — who called almost immediately and offered to help arrange a UK visa. “My whole life switched like that,” Al-Ghoussein marveled. “It was a bit surreal.”

Later, during his 16 years teaching photography at the University of Sharjah, he began taking the staged self-portraits that have allowed him to address concepts that his previous documentary work could not get at.

People began to notice. “I did a few self-portraits that were shown at the Sharjah Museum. And things just seemed to take off from there. It’s funny, you can be working in isolation for years and then, all of a sudden people start paying attention to your work.”

Major institutions are looking, too. The British Museum recently acquired some *K Files* photographs, and the Museum of Fine Arts Houston purchased work from *In Beautification*, a series documenting the development of Saadiyat Island. ▀

KEY TERMS FOR GLOBAL CINEMA

It may sound like a truism to say that film is a global industry. Bollywood movies play in theaters in Los Angeles, while Hollywood movies play in theaters in Bombay. And many films, of course, are produced outside these two great hubs: pictures made in Thailand, South Africa, Egypt, China, Argentina, Finland, among many other countries, circulate on a global market and through the network of international festivals. But what — if anything — do these films share in terms of theme and content? What is “global cinema”? Does such a thing exist?

NYU Abu Dhabi Assistant Professor of Cinema Studies Seung-hoon Jeong is working on a book project in which he identifies and develops key terms for addressing the idea of “global cinema,” which he described as a new frame in which to examine films that comment on phenomena like cosmopolitanism, terrorism, and global capitalism. This current project follows his previous book, *Cinematic Interfaces: Film Theory after New Media*, published by Routledge in 2013.

Seung-hoon believes that many contemporary movies, whether they are produced in Southern California or South Korea, share a way of addressing a global community that values cosmopolitanism and cultural difference. “Since we have a global community that is expanding more and more, differences between groups within a community in terms of race, sex, class, ethnicity, is increasingly less decisive because there is more toleration than there was in the past,” he explained.

Similarities across cultures also extend to values and ideologies. Concepts such as human rights and

equality, ideas that have developed according to their own historical trajectories, have, in a way, become default values shared by many cultures throughout the world. This homogeneity means that some of the most pressing antagonisms today are between the global community and external or excluded forces: “The whole global community wants to be inclusive,” Seung-hoon said. “But on the other hand, this globality isn’t perfect. There are always examples of exclusion.”

Seung-hoon has recently written about how animals and machines are presented as “others” that exist on the boundaries of human society in global cinema. The paper, “A Global Cinematic Zone of Animal and Technology,” published in *Angelaki: Journal of the Theoretical Humanities*, in May 2013, considers how animals and machines can stand in for humans and provide an element of difference that cannot be accounted for by humans.

If nature and technology exist on the edges of society, so too does terrorism, “which is not driven

by states or nations: it’s the abject of the whole global community,” Seung-hoon explained. And whether it’s in the form of a terrorist attack, super storm, or alien invasion, threats from outside society manifest themselves in film in the form of catastrophe.

Seung-hoon notes that a film does not need to be shown internationally to comment on issues that relate to global cinema: “Local films can reflect global phenomena, including multiculturalism, cosmopolitanism, network society, capitalism, and neoliberalism on the one hand, and also terrorism, catastrophe, and immigrant workers’ issues on the other. These are two sides of the same coin of globalization.”

Alternatively, a Hollywood blockbuster, like the final installment of the recent Batman trilogy, *The Dark Knight Rises*, can be considered as it relates to the idea of global cinema, too.

The movie begins with a down-and-out (though still extremely wealthy) Bruce Wayne, who is “retired” not only from his day job as head of Wayne Enterprises, but also from his moonlighting gig as Gotham’s (in)famous vigilante. But Wayne returns as Batman when Gotham experiences a catastrophe: the city is attacked by the mysterious Bane and his gang of terrorists.

Bane threatens the city not only with violence but also with financial instability and social upheaval. His first target is the Gotham Stock Exchange, and his populist rhetoric promotes expropriating wealth from the rich and redistributing it to the poor. “This movie is an example of global issues of terrorism on the one hand, and global financialization on the other, of which Batman is an example, since he is the CEO of a large company,” Seung-hoon explained.

Global cinema often features “abject figures” like Wayne and Bane “who are on the boundary between these two worlds” of the global community and its outside. “They don’t completely belong to the system, but then they are not completely outside it either,” Seung-hoon said. “This kind of in-between state is my focus. I want to develop key terms to map this idea of global cinema.” ▾

Batman faces off with Bane in *The Dark Knight Rises*. Courtesy Warner Bros.



OPPOSITE PAGE: Male pastoralists holding a community meeting under a Dragon's Blood tree, Socotra's flagship species.

THIS PAGE: Inside a rural Socotri house resembling such a tree, a young girl agitates buttermilk in a hollow goatskin.



MIGRATION AND TRANSFORMATION IN THE WESTERN INDIAN OCEAN

Travel has always been an important part of life for Nathalie Peutz, assistant professor of NYU Abu Dhabi Arab Crossroads Studies, and it played a key role in developing her interest and career in cultural anthropology. Following her graduation from the University of Pennsylvania with a Bachelor of Arts in intellectual history, a bicycle trip from Central Europe to South Africa became the pivotal point in shifting her interests from Central Europe, Slavic studies, and history, to the Arab world, East Africa, and cultural anthropology.

Peutz started from Prague and made her way through Eastern Europe, Turkey, the Levant, and North Africa before stopping in Tanzania to work in a Rwandan refugee camp.

“That whole journey helped me decide to study cultural anthropology because I was interested in talking about cultural differences, but not as a traveler or tourist. I wanted to understand how to write about cultural difference and human diversity from an academic and theoretical perspective,” said Peutz.

Peutz did her Ph.D. at Princeton University, and started her graduate research by talking with Somali migrants and refugees living in Yemen, where she had gone to learn Arabic. To get a better sense of where these migrants had come from, Peutz



traveled on a cattle boat from Mocha, Yemen, to Berbera, in Somaliland, to further explore the migration histories and trajectories between these countries. Based on interviews and fieldwork conducted during several trips, Peutz published articles in *Current Anthropology*

and *International Migration* on the stigmatization of Somalis deported from the United States to Mogadishu, either by the US government, or by their parents as a pre-emptive return.

Qualitative studies of deportation, now a burgeoning field, were still just taking shape in the mid 2000s. Seeking to contribute to this field, Peutz co-edited *The Deportation Regime: Sovereignty, Space, and the Freedom of Movement*, which argues that the practice and threat of deportation manifests



Nathalie Peutz, above left, assistant professor of NYU Abu Dhabi Arab Crossroads Studies, grinding wheat with her neighbor. **OPPOSITE PAGE:** Poets prepare for Socotra's annual poetry festival modeled after Abu Dhabi's *Million's Poet*.

and engenders dominant notions of sovereignty, citizenship, national identity, racial purity and class privilege across borders and space.

For her current book project, Peutz has turned to the study of another kind of global regulatory regime: World Heritage sites. She is currently finishing a manuscript on Yemen's Socotra Archipelago — an Indian Ocean island group renowned for its geostrategic location, its relative inaccessibility, and its high percentage of endemic species and biodiversity — that examines the effects of Socotra's World Heritage status on the people who live there.

Peutz only heard about Socotra and the all-weather extension of its airport (permitting flights to and from the main island year round) in 1999, during her first trip to Yemen. Until then, Socotra had been cut off and isolated from the Yemen mainland — and, indeed, the world — for four to five months each year, due to the strong monsoon winds that made dhow travel impossible. With 37 percent endemic species on the island, and just over 50,000 Soqotri speakers in the world, Socotra seemed to be a very

rich site for research. “However, I was still interested in doing more on the Somali migration to the coast of Yemen,” Peutz admitted. But the start of the Iraq war in 2003 disrupted her plans to conduct research in Yemen, as foreigners were no longer allowed to leave the capital, Sana'a. The one place she was allowed to travel to — Socotra.

This idea of Socotra being a “safe haven” piqued Peutz's interest in looking at the archipelago and Socotrans' relationship to the Arabian Peninsula and the wider Indian Ocean region. “We can observe the ramifications of the reverberation of the Arab uprisings not just by looking at Cairo, but also by looking at somewhere as ostensibly remote as Socotra, and seeing how the Arab uprisings are having a profound impact on people's sense of self,” Peutz explained.

Historically, Socotra has experienced several forms of colonial and imperial rule. From the Portuguese to the British to the World Heritage regime, “people are constantly trying to transform Socotra and make it lucrative, or just viable,” Peutz explained.



In her book, Peutz will show how, throughout the history of colonial interventions, development, and resource extraction, Socotrans have managed to develop techniques to both resist and embrace these regimes. “They [Socotrans] are using the language of heritage to lend weight to their recent calls for cultural, if not political, sovereignty,” Peutz said. And recently, as a direct outcome of the revolution in Yemen, Socotrans finally experienced some autonomy again: they have just celebrated their archipelago becoming an independent governorate of Yemen.

Besides teaching and writing, Peutz has also been involved in starting up a major in *Arab Crossroad Studies* at NYUAD. She and her colleagues are finding ways of rethinking Middle East Studies, focusing more directly on the cross-cutting connections between the Arab world and its neighboring regions. Peutz is excited to be involved at the beginning stage of NYUAD's institution building, adding: “It is especially important for the school to have a strong basis in the study of the region where we are located.” ▀

WITH 37 PERCENT ENDEMIC SPECIES ON THE ISLAND, AND JUST OVER 50,000 SOQOTRI SPEAKERS IN THE WORLD, SOCOTRA SEEMED TO BE A VERY RICH SITE FOR RESEARCH

“LAB-ON-A-CHIP” DIAGNOSTIC DEVICE TO DETECT DISEASE BIOMARKERS

While working on developing new 3D-printing techniques for his Ph.D., Assistant Professor of Mechanical and Biomedical Engineering Rafael Song became interested in building smaller objects. “I started learning about microfabrication techniques which allowed me to build things on a micro-scale level,” said Song. “I realized there is a huge market potential to develop compact, portable, biomedical devices.” When the application of microfabrication to biomedical areas became popular during his time at the Massachusetts Institute of Technology, it spearheaded Song’s career toward a convergence of biology and engineering, also called bioengineering.

With his main research topic on biosensing, Song is currently developing an ultra-sensitive biosensor for the detection of various disease biomarkers. “If you can detect certain biomarkers at very early stage, then you can detect the disease and have a higher chance to treat it successfully,” Song said.

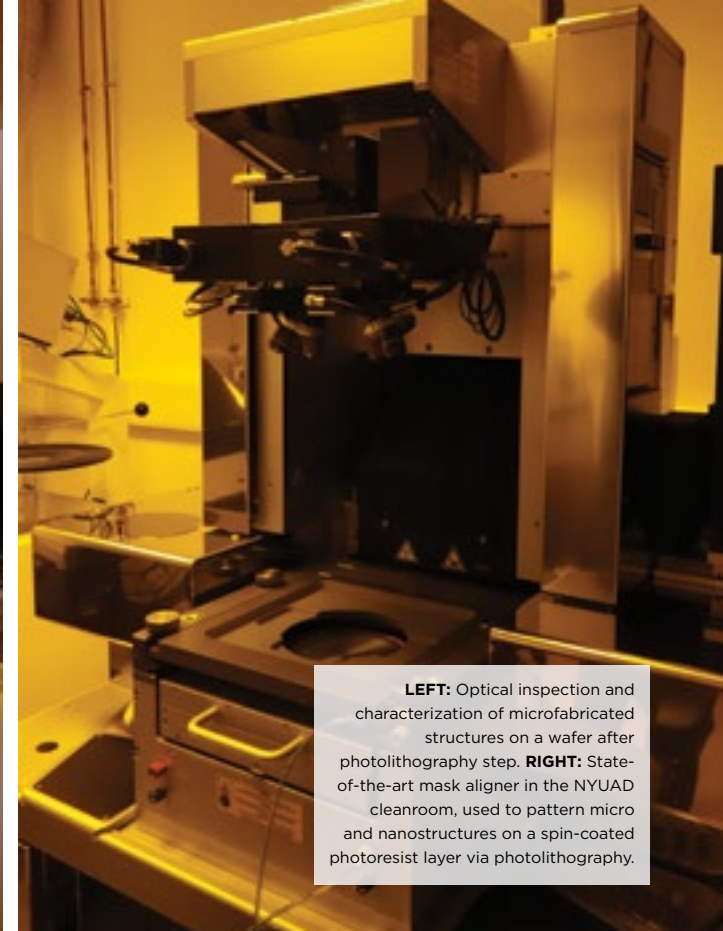
A disease at a very early stage contains only a very low concentration of biomarkers, often less than a picogram per milliliter, and the current biosensors in the market are either too slow or incapable of detecting small concentration levels. This means that by the time the sensor detects biomarkers at a sufficiently higher concentration level, the disease would have progressed. “Hence, the goal is to develop a biosensor that can detect a small amount of biomarkers at a very early stage and rapidly,” said Song.

Currently commercially available biosensors are not able to detect molecules below a concentration of one picogram per milliliter. Song and his team in the Micro- and Nanoscale Bioengineering group at NYU Abu Dhabi are working to push down the threshold to below one picogram per milliliter into low femtomolar concentrations or below. While the more common techniques use nanomaterials such as nanowires and carbon nanotubes to detect

smaller amounts of biomarkers in blood or fluid samples, Song came up with a different approach. He couples existing biosensors with an electrokinetic concentrator chip, to concentrate the molecules at a specific site of detection.

By using an electrokinetic concentrator chip, molecules are moved to a concentrated spot (detection site) electrokinetically to increase detection sensitivity and detection speed. “So far we have been able to increase the local concentration of DNA by three orders of magnitude, or 1,000 fold, after 30 minutes,” said Song. This electrokinetic concentration method can be extended to any charged biomolecules such as proteins, micro particles, or even ions.

With the molecules of interest now closer to the sensor, there is a higher chance of interaction to detect the presence of abnormal molecules. Called the Ion Concentration Polarization (ICP) method, Song uses the basic physical phenomenon of applying electrical potential difference across an ion-selective membrane. This polarization creates an ion depletion region, repelling all charged molecules from the membrane and allowing a formation of a concentrated plug when coupled with a pressure- or electroosmotically driven flow inside a microfluidic channel.



LEFT: Optical inspection and characterization of microfabricated structures on a wafer after photolithography step. **RIGHT:** State-of-the-art mask aligner in the NYUAD cleanroom, used to pattern micro and nanostructures on a spin-coated photoresist layer via photolithography.

As he continues to develop this research, Song will collaborate with Professor Rastislav Levicky from NYU Polytechnic School of Engineering, who has been working on morpholino based detection for the past few years. Conventional morpholino sensors have low detection sensitivity and are slow. The coupling of Song’s electrokinetic concentrator chip with Levicky’s morpholino based sensor will address both issues. This NYUAD-Polytechnic School of Engineering collaboration has been supported by NYUAD’s Research Enhancement Fund for two years, and based on this work, new proposals have been submitted to various US funding agencies and a joint publication is in preparation.

Essentially creating a “lab-on-a-chip”, Song is trying to shrink the size of a conventional lab by integrating the sample processing steps and a detection step all in one chip with microfabrication technology borrowed from the semiconductor industry. To enable research in lab-on-a-chip technologies at NYUAD, a state-of-the art microfabrication core facility has been established.

With no limitations on testing different disease types, this technique has a broad range of possible applications. “This chip is so flexible, it can be tailored toward detection of any cancer-related biomarker or any disease biomarker,” Song said. “My ultimate goal is to develop a point-of-care, portable diagnostic tool for global health.”

NYUAD’s strategic location also comes into play here. With a new initiative in the Engineering Division at NYUAD called Engineers for Social Impact that emphasizes experiential learning by students through field work and developing locally sustainable engineering designs and technologies, the outcome of Song’s research could potentially be integrated into its Global Health program. This initiative would also encourage students to “come up with creative solutions that will improve the lives of end users at the bottom of the socio-economic pyramid,” Song said.

“We are so well positioned with our location in Abu Dhabi that we can bring students to sites and try to implement our technology where it’s urgently needed.” ▀

NEW HARDWARE ARCHITECTURE FOR SECURITY AND PRIVACY

Michail Maniatakos began creating software – and selling it – at the age of 14. Since then he has moved on to computer problems far more complicated than the scheduling software he sold to hairdressers and the archiving software bought by photo studios in Athens, where he grew up.

Today Maniatakos is an assistant professor of Electrical and Computer Engineering at NYU Abu Dhabi and laboratory director for the University's faculty research lab Modern Microprocessor Architectures Laboratory, known as MoMALab.

His research is now focused on security, increasingly essential in a world where so much vital work is done via computers and where the internal architecture of computers has not changed much since the 1970s. Hardware security, Maniatakos's chosen research field, has become a constant concern.

He is currently looking into a new computer architecture in which all data will be encrypted by default.

"Researchers have managed to extract information from a computer, by directly observing the internal values of the storage elements," Maniatakos explained. "So if we can convert everything in the hardware to an encrypted version of the data, even if you were to look into my computer, you would not be able to find direct information."

Trusted platform modules now on the market can secure information that is already in a system, but these still require users to play an active role. "By building a new computer with an embedded system that will natively encrypt information, the system is then secured by default," Maniatakos noted.

To ensure correct computation, the data must be encrypted with specific cryptographic schemes that

allow meaningful manipulation of encrypted data. Therefore, Maniatakos uses specific "homomorphic" encryption schemes, in which there is a 1:1 association between operations in the encrypted and unencrypted domains. That means that when the result of a homomorphic operation is decrypted, it will match the value of the corresponding unencrypted operation.

General purpose devices such as PCs and laptops typically consist of architectures with several instructions, such as addition, comparison, multiplication, etc. In the encrypted domain, however, the architecture cannot differentiate between instructions, since all data is encrypted. To address this problem, Maniatakos implemented a simple, powerful architecture that employs only one instruction. The judicious selection of that one instruction enables general-purpose computation – similar to typical PCs and laptops.

Maniatakos's research is currently at a software prototype stage. A hardware architecture, to be ported to a Field Programmable Gate Array (FPGA), is currently under development before making it into a fabricated chip (also called Application Specific Integrated Circuit, or ASIC). "But for now, we're still working on improving the performance, security properties and applicability of this prototype," Maniatakos said.

When successful, the fabrication of the encrypted chips will benefit anyone using a PC and especially those using cloud computing, typically users with a heavy workload but limited local hardware capacity.



Laboratory Director Michail Maniatakos, right, works with a student in NYUAD's Modern Microprocessor Architectures Laboratory.

Buying cloud space allows the user to outsource the workload, but there is no way to ensure security; anyone may be peeking at the data.

Companies do have the option of buying their own servers, but purchasing and maintaining this hardware is not cheap. Encrypted hardware promises to be cost effective, helping an animation-movie company, for example, to prevent its upcoming movie from being leaked, or ensuring that a doctor who is consulting a central database does not unwittingly reveal a patient's information. Maniatakos said he hopes his work will allow users to "tap into the knowledge of the world in this computer-savvy era but still be able to protect their identity."

In addition to hardware security, Maniatakos is also researching security in industrial embedded systems such as power grids. "Our electricity providers are smarter now. Using something called the smart grid, they know your exact consumption, when and where you are using your energy,"

Maniatakos noted. The smart grid allows users to fine-tune where electricity goes, and even store energy in their houses to avoid peak-time electric surcharges. But these smart devices, are also vulnerable to all kinds of cyber-attacks, viruses, and malware.

The implication of such attacks is enormous: these smart devices are connected to electrical substations and linked all the way to power-utility control rooms. Once a hacker works his way up the line, he could switch off the electricity for millions of people, or worse, affect a nuclear power plant.

Recognizing the importance of such research work, Con Edison, a major electricity provider in New York, gave a hefty research grant to Maniatakos and his MoMALab team to further investigate smart-grid cyber security and find ways to protect the grid.

In the ever-changing landscape of technology, Maniatakos looks forward to continuing to improve these vital systems. ▀

ENGINEERING STRONGER CROPS

“Geneticists have had a lot of success with corn,” said Douglas Cook. “The kernels are bigger, the ears are bigger, the yields are bigger.”

And yet there’s a hint of concern in his voice: all that corn is heavy, and too often the plants’ stalks buckle, dooming the plant. Cook, an assistant professor of Engineering at NYU Abu Dhabi, is working at the interface of crop science and engineering to solve the problem.

It is a costly one: Zea mays, commonly known as maize or corn, is the world’s leading grain crop, but between 10 percent and 20 percent of what’s planted is lost to stalk collapse, he said. Reducing the failure rate by just one percentage point, he adds, could increase the annual value of the global crop by USD 2 billion.

Breeding for bigger sturdier stalks, Cook said, would be “the easy answer but the dumb answer” because that would take nutrients away from the kernels, the plant’s payload.

Left to itself, Zea mays might solve the problem through evolution, but that would be “slow, sloppy, and wasteful ... we don’t have time to wait for an evolutionary solution.” He prefers the engineering approach: analyze the problem to create an intelligent solution.

But corn stalks are not nearly as uniform as, say, steel beams. And the load they must carry depends

not only on the plant but also on weather and many other factors difficult to quantify. “You can predict everything about a bridge,” Cook said, “because the geometry, the materials, and the loading are well known. But with biological systems everything is variable.”

So traditional engineering methods alone are not sufficient. Instead, Cook’s team at the NYUAD Biomechanics Laboratory is using x-ray CT scans

and mechanical tests to measure the geometry and material properties of corn stalks. This data is then used to create hundreds of computational models of stalks, “virtual specimens” that are randomly generated to mimic the variation patterns seen in nature. The resulting “cloud” of data will be analyzed to pinpoint how the corn stalk can be modified,

through breeding, to optimize strength.

Cook has already learned important things by examining broken stalks in Iowa, the heart of America’s corn belt, where he goes every summer: failures are almost always at the “knuckles,” the nodes between stalk sections. Between nodes, a corn stalk is slim and uniform, with a thin rind. But at the knuckles, both stalk and rind are thicker and



Douglas Cook, assistant professor of Engineering at NYU Abu Dhabi, is using x-ray CT scans and mechanical tests to measure the geometry and material properties of corn stalks in an effort to discover how the corn stalk can be modified to prevent stalk collapse.



REDUCING THE FAILURE RATE BY JUST ONE PERCENTAGE POINT COULD INCREASE ANNUAL VALUE OF THE GLOBAL CROP BY USD 2 BILLION

denser. Engineers know that structural stresses can rise dramatically in regions where both geometry and material change rapidly, and this means trouble. The nodes are often too weak for the added stress imposed by fatter kernels and bigger ears. “A systemic failure means there’s a systematic weakness,” he said, “and I think we can fix it” — probably through simple selective breeding.

A solution is vital if yield per plant is to be further increased. And the work promises benefits beyond corn: wheat, rice, oats, bamboo, and bananas are all from the same family of plants, so an understanding of corn could be applied to other important crops as well. As food for people and animals, these are, Cook

noted, “the foundation of the human diet.” And he believes that what scientists learn about corn may prove useful in fruit and vegetable production, too.

Despite these alluring prospects, Cook said, little work has yet been done on crop biomechanics. There’s been endless research on human-body biomechanics, and plenty of botanical crop science. There is even, he said with a hint of amazement, “a whole journal devoted to the study of wood.” But “we’ve been reading the literature, and nobody has studied the biomechanics of corn.”

So that is what Cook and his team are doing. The results may have broad effects for agriculture yields around the world. ▀

DESIGNING A BETTER CHIP

As one might imagine, designing a computer chip is a painstaking and intricate process. Creating the blueprint for a chip that comprises multiple layers of complex circuitry involves the creation of schematic diagrams to map electrical circuits, floor planning to manage where each component fits, and routing connections between those components — not to mention a rigorous process of simulation, testing, and refining before the chip is ready to move on to fabrication. Designing one chip requires teams of engineers and a significant financial and time investment.

Computer chip counterfeiters have found a shortcut. By taking existing chips, opening them up and separating the individual layers, they can take a top-down view and use image-processing tools to stitch the layers back together to effectively reverse engineer the original design. As NYU Abu Dhabi Assistant Professor of Engineering Ozgur Sinanoglu explained, this illegal practice has significant economic, security, and reliability implications. In addition to the potential to reveal insights into critical security applications, the theft and cloning of chips affect companies and individuals whose livelihood depends on this intellectual property.

Sinanoglu and the members of his Design-for-Excellence lab at NYUAD have received recognition, and a USD 500,000 grant from the US National Science Foundation, for their work on developing and advancing techniques to build protections — against intellectual property, reliability, and security-related threats — directly into the chip-design process.

In the case of reverse engineering, Sinanoglu is investigating ways to optimize the use of camouflaged gates with dummy connections (created by external casing with no wiring) to disguise the actual functionality of individual components.

“Normally if a component has a certain function,

it looks a certain way,” he explained. “By designing what looks like a union of two different components from a top-down view, even though in reality it is still only performing one function, it creates ambiguity for reverse engineers trying to analyze the images; they are not able to figure out what the component does.”

While designs for camouflage gates are available from select companies in the industry, it is still a nascent technique lacking a structured methodology and approach to make decisions about how and where to effectively use them on a chip to provide a sufficient level of security. Another problem: camouflaged components cannot be used freely in the design due to cost considerations. Being bigger, they consume more space and power, creating an optimization problem.

Sinanoglu, together with members of the NYU Polytechnic School of Engineering — doctoral student Jeyavijayan Rajendran, undergraduate Michael Sam, and Professor of Electrical and Computer Engineering Ramesh Karri — have analyzed the connections and functionality of individual components on a chip to create an algorithm. It provides a theoretical solution to identify chips that can most effectively camouflage in order to meet a certain level of security while controlling the cost. Findings were published in



Ozgur Sinanoglu, leader of the Design-for-Excellence lab at NYUAD, which has received a grant from the US National Science Foundation for their work developing and advancing techniques to build protections directly into the computer chip design process.

the paper “Security Analysis of Integrated Circuit Camouflaging”, which won the Best Student Paper recognition from among 530 submissions at the 2013 Association for Computing Machinery Conference on Computer and Communications Security, one of the world’s top computer security conferences.

In 2013, Sinanoglu and Karri were also awarded a three-year US National Science Foundation grant, following a highly competitive, peer-reviewed proposal process, to continue their research in improving existing methods for computer chip hardware security in the areas of logic encryption and split manufacturing.

“With electronic chips passing through many hands as they are designed in one place and fabricated in another, designers of the chips have less control of the process than ever before,” Sinanoglu explained.

In addition to intellectual property concerns, this decentralized process creates security and reliability threats. Hardware such as Trojans can be inserted

directly onto chips during the manufacturing process, allowing hackers to access confidential information or attack the chip remotely.

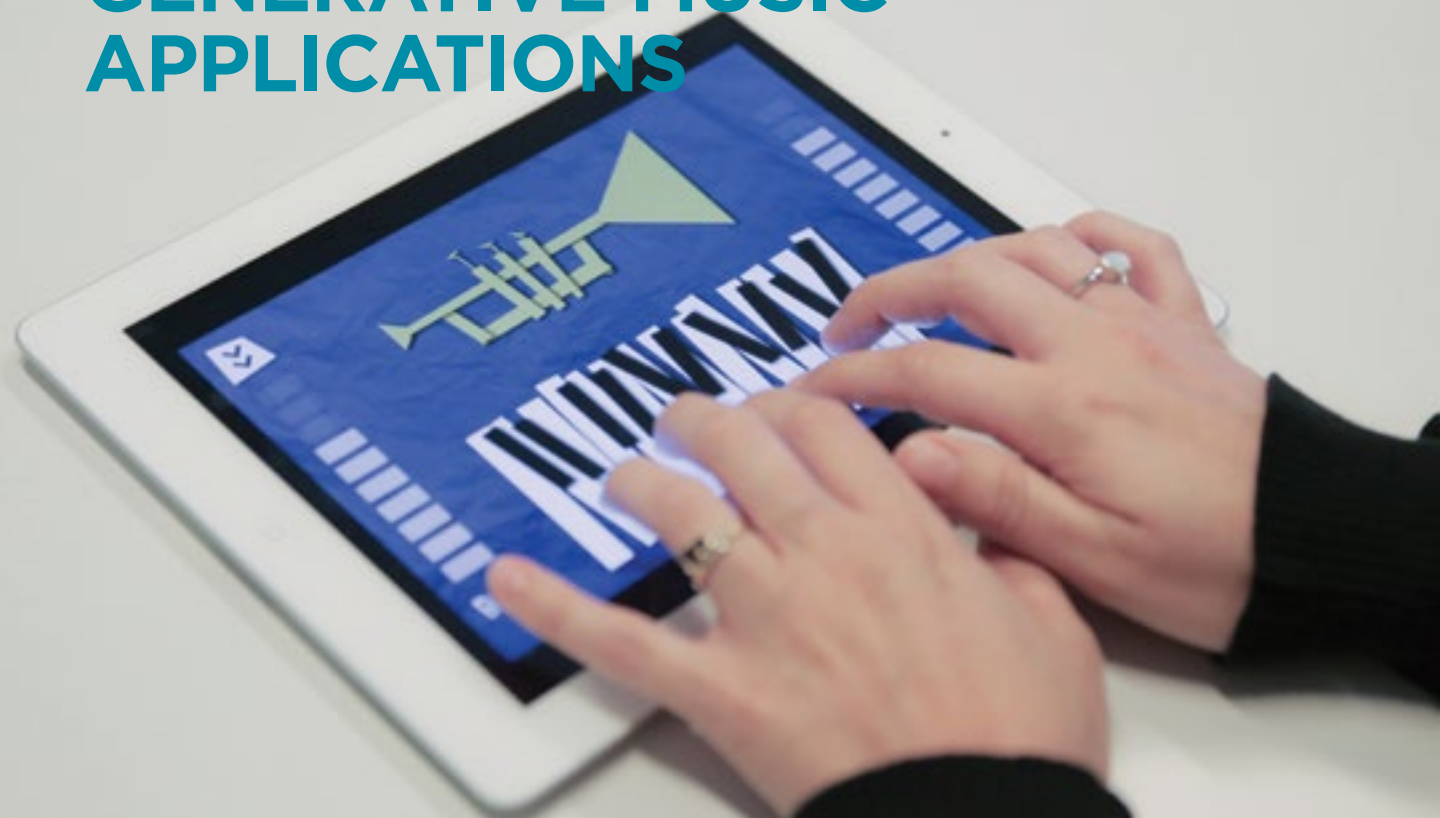
Logic encryption helps to protect against this by creating a lock and key mechanism to control the chip’s functionality by including components onto the chip hardware that can only be opened by a digital security key. Split manufacturing is a technique to manufacture part of the chip in one fabrication facility and the rest in another, with the components being merged afterwards, to ensure that no single manufacturer receives the full design. Both these processes are currently randomized, with logic encryption implemented by choosing control locations arbitrarily and manufacturing being split at an arbitrary point.

“While these security methods are promising, they are still new to the market and there is significant room for improvement. Knowing how and where to place these controls is important, and determining specific points to place controls or split the manufacturing has proved to provide more security than a randomized approach,” Sinanoglu said.

Sinanoglu and Karri were also awarded a three-year USD 180,000 grant for their project on “smart logic encryption” in 2013 by the Semiconductor Research Corporation (SRC) — a consortium of leading semiconductor companies such as Intel, IBM, and GlobalFoundries — in partnership with the Advanced Technology Investment Company (ATIC), soon to be Mubadala Technology. The research team has made important progress in this area. In addition to developing a way to blend the lock mechanism into the design so that it is not easily detectible, the paper also discusses solutions to protecting against an automated attempt to unlock the key. A barrage of arbitrary key attempts will result in the chip producing nonsensical information. Their paper “Fault Analysis-based Logic Encryption” is due to be published in the journal *IEEE Transactions on Computers*.

“Computer chip security is a real problem and it is getting more pressing as people encounter more of these counterfeit chips,” Sinanoglu said. “As people understand the security and reliability issues of these problems, people are paying more attention.”

INVISIBLE HAND OF GENERATIVE MUSIC APPLICATIONS



Carlos Guedes, associate professor of Music at NYU Abu Dhabi, has composed for orchestras and pop musicians, and just about everything in between. But recently, he has been working on developing computer programs that produce their own music.



TOP: Gimme Da Blues, an interactive and generative music app designed by Carlos Guedes, above.

Generative music programs are applications that create music according to pre-determined principles. They can receive an input from musicians – or even dancers – and respond to the input according to those principles. The degree of response is variable, so that programs can be either deterministic, and create music that is expected, or indeterministic, in which case it is harder to know what the program will produce. Guedes is most interested in indeterministic systems in which the applications create music that cannot be anticipated. “We give the rules to the computer,” he explained, “and we have an idea what might happen, but we don’t know for

sure. And that’s a good thing, because it makes the musician interact with the machine.”

A system he created collects rhythmic information from the movement of dancers, called “musical cues,” and translates this information into music. With the movements of their body the dancer can control the tempo of a musical score, and a musician accompanying the score can respond to the changes. This way, “the musician can communicate with the dancer in real-time,” Guedes said.

The process of creating a generative music application requires not only the art of musicians, but also the technological knowhow of computer scientists and engineers. Before coming to NYUAD, Guedes worked with a team of programmers at the Sound of Music Computing Group at the Institute for

did not play as well as people who did. He thinks that tools like Gimme Da Blues could be used to educate people in different music styles. “Especially here in Abu Dhabi where there are many different kinds of music, you could train students in Arabic, Indian, or African music,” he said. This opens new doors for classroom learning: “Instead of having the traditional music appreciation class where students sit and listen to music, you could have them play along on an app, and they could create a gestural relationship with that music,” he explained.

Another major potential application for generative music is the video game industry. Imagine you are a knight riding through a medieval forest. The game’s music is light and mirrors the bucolic scene. Suddenly you are attacked by a band of

“INSTEAD OF HAVING THE TRADITIONAL MUSIC APPRECIATION CLASS ... YOU COULD HAVE THEM PLAY ALONG ON AN APP, AND THEY COULD CREATE A GESTURAL RELATIONSHIP WITH THAT MUSIC”

Engineering and Computer Science (INESC TEC) in Porto, Portugal. He described the team as a group of “hybrids,” who are interested in working across disciplines. Guedes hopes to recreate a similar group here in Abu Dhabi: “The amount of creativity you can get from people with a bunch of different skills is really powerful,” he said.

With the Portugal-based team he designed an interactive and generative music app for the Apple iOS operating system called Gimme Da Blues. Double bass and drums are played by the application, while users lead with trumpet and/or piano. Depending on how the user plays, the bass and drums respond with more or less syncopation and intensity. Users can change the music style, key, tempo, and the volume of the accompaniment. The app also lets users record and share their performances.

With Gimme Da Blues, Guedes and his team observed that people who were unfamiliar with jazz

thieves. The music changes, and mimics the pace of the ensuing struggle. “The game industry spends more money on music than Hollywood. But they are doing it in the traditional way right now, by using orchestras,” Guedes said. (The game *Spore*, released in 2008, featured generative music by Brian Eno, but generative music in video games has yet to gain widespread use in the industry.)

Now Guedes is thinking about other interdisciplinary projects that can be done here in Abu Dhabi. His latest idea is to film and record a dancer moving through the desert, and then remove the image of the dancer in post-production. The effect would be to see and listen to sand being transformed by a pair of invisible feet – only the result of the dancer’s gestures would be seen and heard. Not so different from the way a generative music app could help guide the hand of a music student over virtual keys. ▀

GIFT OF THE FACE

Shamoon Zamir's new book, *The Gift of the Face: Portraiture and Time in Edward S. Curtis's The North American Indian*, offers a reconsideration of the most influential photographic record of the Native Americans of the United States. Curtis dedicated himself to the project for 25 years during which time he took more than 40,000 photographs — just under 2,500 of these were published and almost half of them are portraits.

The North American Indian, published between 1907 and 1930, was a collaborative effort that brought together Curtis, academic and photographic assistants, editors, printers, and Native American translators, guides, and cultural brokers.

The project took an enormous amount of time, resources, and labor to produce. For the photographic reproductions, Curtis chose photogravure, the best and most expensive process for reproducing a photograph. Partially funded by the industrialist J.P. Morgan, and with a foreword by US President Theodore Roosevelt, the team's combined labor resulted in 20 volumes of images and ethnographies and 20 photographic portfolios; a complete set was priced at around, USD 3,000 in 1930 (worth approximately USD 41,800 today).

Zamir's study, however, eschews comprehensiveness for in-depth analysis of a handful of Curtis's images: "Each of the eight chapters takes one image, and spins out from it a complicated argument about a particular aspect of the work," said Zamir, who is associate dean of Arts and Humanities and associate professor of Literature and Visual Studies at NYU Abu Dhabi.

At the heart of Zamir's reading of Curtis is the argument that the photographs are more than mere illustrations for the anthropological text; they do not simply accompany the text but must be seen as "argument making pictures" claiming an equality with the text. The pursuit of this argument allows Zamir to re-assess the place of Curtis both within the histories of American photography and also of early visual anthropology.

While many previous commentators have criticized Curtis for romanticizing the Native Americans and erasing all evidence of historical violence from his images, Zamir proposes that there is often a complex engagement with history and time in the work of Curtis. Where these commentators have argued that Curtis manipulated his subjects, Zamir demonstrates that there is strong evidence to suggest that the project is the result of a more consensual collaboration.

Some of the Native Americans that Curtis photographed were extremely powerful men: Sitting Bull, Geronimo, and Plenty Coups, one of the great Crow leaders of the early 20th century. "Plenty Coups went to the White House four times to negotiate treaties with the president of the United States. The idea that Curtis was somehow manipulating these people seems to me absurd," Zamir said. "So, if Plenty Coups or Geronimo are dressed up in traditional regalia, it's because they had a reason for working with Curtis."

There is also "a visual archive of evidence" that supports Native American collaboration in the portraits. And this type of evidence has not been considered by previous critics. "I can honestly say that there are very few portraits that you would say are awkward. There's no way you look relaxed in front of the camera unless you are relaxed in front of the camera. This may seem very tangential, and perhaps no scientist would accept this argument," he acknowledged. "But if you work in the arts, evidence like this is as important as anything else."

In one chapter, Zamir employs historical research



A portrait of Alexander B. Upshaw, Curtis' Crow informant. The portrait appeared in Curtis' massive *The North American Indian*.

that complicates the narrative of Alexander B. Upshaw, Curtis's Crow informant who also sat for a portrait.

Upshaw was educated in the assimilationist Carlisle Indian Industrial School in Carlisle, Pa. In his younger years, he rejected Native American culture and urged his classmates to do the same: "Unless we break away from our tribal relations and go out into the world as men and women, we will remain Indians and perish as Indians." (He even wrote a letter to the school newspaper denying that he had donned traditional dress for a portrait taken in Omaha, Neb.)

Yet, a few years later, Upshaw posed bare-chested, wearing a headdress for Curtis's book.

"So the critics say, 'Look what Curtis did to Upshaw!' And the real question for me is: 'Why did Upshaw decide to sit for the portrait?'" said Zamir, who believes that Curtis could have never

SOME OF THE NATIVE AMERICANS CURTIS PHOTOGRAPHED WERE EXTREMELY POWERFUL MEN: SITTING BULL, GERONIMO, AND PLENTY COUPS, ONE OF THE GREAT CROW LEADERS OF THE EARLY 20TH CENTURY

manipulated Upshaw in ways that critics have argued.

"One of the conjectures that I make, using evidence I've found about Upshaw's life, is that this was actually part of a radicalization moment on the Crow reservation, and young, educated Crows, like Upshaw, were being pushed to the forefront in terms of negotiations" with the US government.

With this kind of work, "you open up new lines of inquiry where the old lines of inquiry seem to be problematic, and I'm hoping that someone else takes up the next phase of this research," Zamir said. "There may be documents out there somewhere that I and other Curtis scholars haven't found. Complicating the narratives of cross-cultural encounter seems imperative to me."

The Gift of the Face: Portraiture and Time in Edward S. Curtis's The North American Indian, published by University of North Carolina Press, will be available in June 2014. ▀

STRONG PULL OF BLACK HOLES

Every second, intense beams of maser emission (like laser emission but at radio frequencies) arrive on Earth from clouds of water vapor orbiting supermassive black holes (SMBHs), millions to billions of times the mass of the Sun, at centers of galaxies hundreds of millions of light years away. Ingyin Zaw, assistant professor of Physics at NYU Abu Dhabi, is using the largest and best radio telescopes in both the Northern and Southern hemispheres to tease out information from these maser systems in the attempt to unravel the nature and behavior of their host SMBHs.

Although SMBHs are only a small fraction of the total mass of the galaxies they inhabit, their growth and evolution are intimately linked with that of their host galaxies across cosmic time. A key in regulating this relationship is the process of accretion — how gas and dust from the galaxy falls into the SMBH — and outflows — material that is driven from the vicinity of the SMBH. Both accretion and outflows influence physical processes, like star formation, in the host galaxy.

Water masers occupy a unique location within a few light months to a few light years of the SMBH. They are in a region where the gravity of the SMBH dominates over that of the galaxy. From their location and motion, many properties of the SMBH and surrounding material can be deduced, including the mass of the SMBH, the geometry and temperature of the material around the SMBH, the shape of outflows, and the distance to the host galaxy.

“I’m amazed at how well we can study objects so far away,” said the Burmese-born, Harvard-educated Zaw. The maser emission, up to hundreds of millions times weaker than the average TV signal, is discovered by large single-dish telescopes, approximately 100-meter versions of rooftop satellite dishes. Then, using very long baseline interferometry — a group of telescopes that spread out over the Earth but act as one — astronomers

are able to image the individual maser clumps. The resolution produced by this method is the equivalent on Earth of being able to see the face of a person standing on the moon.

In addition, Zaw wants to combine this information with data of light emitted at other frequencies, since different physical processes at different locations near the SMBH emit at different frequencies. This way, she will be able to disentangle the complex physical conditions near the SMBH, then build models and compare them to theoretical predictions.

Zaw was in Australia in April 2014 to work with the Southern Hemisphere’s largest radio telescope, the 70-meter Tidbinbilla antenna, a part of NASA’s Deep Space Network, near Canberra. She and Lincoln Greenhill, a senior researcher at the Harvard-Smithsonian Center for Astrophysics, are co-principal investigators on the Tidbinbilla AGN Maser Survey, known as TAMS. The seven-person team, which spans three continents, comprises Zaw’s postdoctoral researcher Aquib Moin and collaborators at Australian National University’s Jet Propulsion Laboratory and the Canberra Deep Space Communication Complex. The arrangement is ideal for splitting up observing sessions that can be scheduled for any time, day or night, said Zaw. She is also excited to supervise research projects



The Southern Hemisphere’s largest radio telescope, the 70-meter Tidbinbilla antenna in Canberra, Australia. Photo by Shutterstock

of NYUAD students using the data from the TAMS project.

Zaw and two other NYUAD Physics faculty, Visiting Professor of Practice of Physics Mallory Roberts and Assistant Professor of Physics Joseph Gelfand, are also working on a partnership with the National Radio Astronomy Observatory’s 100-meter Green Bank Telescope in Green Bank, West Virginia, to conduct maser and pulsar observations.

The Australian project has been allotted 1,200 hours of telescope time to be spread out over the next few years. During her April 2014 trip, Zaw calibrated the instrument and prepared to begin the first year of study, designated as a pilot phase. “We need cold dry nights,” she said, and the Australian winter fits that requirement.

“When it’s all set up,” she added, her tone revealing her enthusiasm for the project, “I’ll be able to sit in my office at NYU Abu Dhabi and control the telescope remotely. It is truly a privilege.”

Zaw cites a quote from the poem “Planetarium” by Adrienne Rich that inspires her:

*I am bombarded yet I stand
I have been standing all my life in the
direct path of a battery of signals
the most accurately transmitted most
untranslatable language in the universe
[...]
I am an instrument in the shape
of a woman trying to translate pulsations
into images for the relief of the body
and the reconstruction of the mind. ▀*

CONTROLLING SEROTONIN WITH LIGHT



“On the outside of our bodies, we look fairly symmetric,” NYU Abu Dhabi Associate Professor of Chemistry Timothy Dore explained. “We have two hands that are mirror images of each other, two eyes, a nose and a mouth in the center. But internally, things are not so balanced. Your heart is a little to the left side; your liver is on the right side. So, internally, your organs are not symmetrically arranged.”

This characteristic, called left-right asymmetry, is established very early on in the development of the embryo, and the neurotransmitter serotonin plays an important role in its establishment. Dore and his colleagues reported in the December 2013 issue of the journal *Chemistry & Biology* a new tool for studying the role serotonin plays in the development of left-right asymmetry and the neurotransmitter’s role in other physiological functions.

Serotonin does many things: it influences appetite, memory, learning, pain, and mood. Some drug treatments alter the way serotonin works in the brain. For instance, anti-depressant drugs such as Prozac and Zoloft are in a class of pharmaceuticals called selective serotonin re-uptake inhibitors, or SSRIs. These drugs increase the level of serotonin in the synaptic cleft between neurons by preventing serotonin from being absorbed back into the presynaptic neuron.

Since serotonin plays a role in many different brain functions, Dore and his team wanted to develop ways to turn serotonin signaling on in an organism. “In my laboratory at NYUAD, we are interested in developing photochemical switches — these are switches that can be turned on by applying light. So, using our technology, we built a chemical compound that is composed of a photosensitive switch and serotonin,” Dore said. The photo-sensitive switch is attached to serotonin through a covalent bond.

“When we attach the light-sensitive molecule to serotonin, the serotonin becomes inactive. But when we shine light on this light-sensitive molecule — or what’s more technically known as a photo-removable protecting group (PPG) — the light breaks the bond between the PPG and the serotonin and the serotonin is released in its active form,” Dore explained. Once the PPG releases the serotonin,

the PPG becomes “an innocent bystander” in the organism, while the serotonin functions in the way it normally would.

Though other work has been done on this topic, Dore and his team have done something novel. “One thing that’s different about our technology is that it can utilize a non-linear optical process called two-photo excitation, which is a way of very tightly controlling within three dimensions the volume of which a particular cargo — in this case serotonin — is released,” Dore said.



Timothy Dore, associate professor of Chemistry and head of the Dore Laboratory.

This is important because the location in which a neurotransmitter is released in the brain influences the signal the neurotransmitter causes. “Imagine a neuron and its dendritic tree,” Dore said. “If you can pinpoint the release of the neurotransmitter on one dendrite, you might

get a different result than you would by releasing the neurotransmitter at another dendrite. We haven’t demonstrated the use of two-photon excitation for activating the serotonin in an organism yet, but we have done it in a chemistry context.”

Dore hopes that with more work being done on the topic, the compound they created could help scientists get a better understanding of the cause of seizures and the role serotonin plays in that process. “Much of this project was driven by our desire to understand how coherent neural activity — like an epileptic seizure — propagates through the brain. Serotonin plays an important role in that process,” Dore said. ▀

THE COMPLEX INTERPLAY OF GENES AND ENVIRONMENT

Youssef Idaghdour’s “eureka moment” on the old issue of nature vs. nurture came when he was back in his native Morocco, examining genetic expression in a small sample of Berber individuals for his dissertation.

But his interest in genetics started with birds, not people. “I’m a bird-watcher,” Idaghdour said cheerfully.

After earning a Bachelor of Science at the University of Agadir, he worked in a wildlife conservation center where houbara birds were bred in captivity. The work’s focus on issues of genetic diversity led him towards genomics and a Master of Science in molecular genetics at the University of Leicester, where he worked in the laboratory in which Sir Alec Jeffreys had discovered the process known as genetic finger-printing. Idaghdour did his Ph.D. at North Carolina State University on a Fulbright Scholarship, before becoming a postdoctoral fellow at the Sainte-Justine Research Center in Montreal, Canada.

In his office at NYU Abu Dhabi’s Center for Science and Engineering, he recounted reading a



study while he was in North Carolina doing research on free-range and captive wolves. The study found that while the two groups' genetic makeup was similar, the main difference in whether certain genes were turned on or off appeared to be related to the animals' status as captive or free. Environment, it seemed, was a vital factor in which genes were expressed.

To test this hypothesis in humans, Idaghdour returned to Morocco in 2006 and studied blood samples from Amazigh, or Berber, individuals, some living the ancient nomadic life, some mountain farmers, and some city-dwellers from the coast — but all with strong genetic similarities. As he reported in his doctoral dissertation, as much as a third of all genes expressed in blood were “found to be differentially expressed among lifestyles.”

Biological processes, Idaghdour said, are complex; there are multiple steps from the simple gene to the phenotype, the observable characteristics that result from the combination of genotype and environment. One of the first key steps, he summarized, is the transcriptome — the sum of the products of genes actively expressed at a given time in an individual. His Berber subjects were found to have dramatic transcriptome variations among the groups.

A larger follow-up study on Amazigh and Arab populations, conducted in 2008 by Idaghdour, replicated the findings of the first study and demonstrated the major influence of lifestyle and geography on gene expression.

In other words, Idaghdour explained, “the real answer to the question of ‘nature-vs.-nurture’ is not either-or, but a combination. Interaction is the key word in what I’m doing.” In layman’s terms, he said, the basic idea is that “for complex disease such as diabetes, cancer and asthma, where and how you live are major determinants of the aspects of your health. But genes define one’s baseline risk.” That is, genes protect you against or predispose you to complex diseases, while the environment is more influential in triggering the disease.

Idaghdour is still analyzing the data from

his subsequent project, looking at the risk of cardiovascular disease in a sample of 1,000 people in Montreal, Quebec City, and the rural Saguenay region, all in Canada’s Quebec province. Those findings will, he hopes, cast more light on the nature of “gene-environment interactions.”

But it’s a big job. With 20,000 genes in the human genome, not to mention mutations, the number of conceivable combinations with environmental factors is formidable.

Idaghdour’s next research effort focuses specifically on the Arabian Peninsula, where diabetes is a serious public health challenge, especially among the region’s residents whose diet and lifestyle have changed dramatically in just one or two generations. “The prevalence of diabetes here is striking,” said Idaghdour and “must be caused by both genetics and environment together.”

He’s hoping to work with the NYUAD Public Health Research Center on a detailed study of Emiratis, measuring the way environment can alter gene expression in ways related to the disease. And for his upcoming NYUAD projects, the university’s High Performance Computer will be needed.

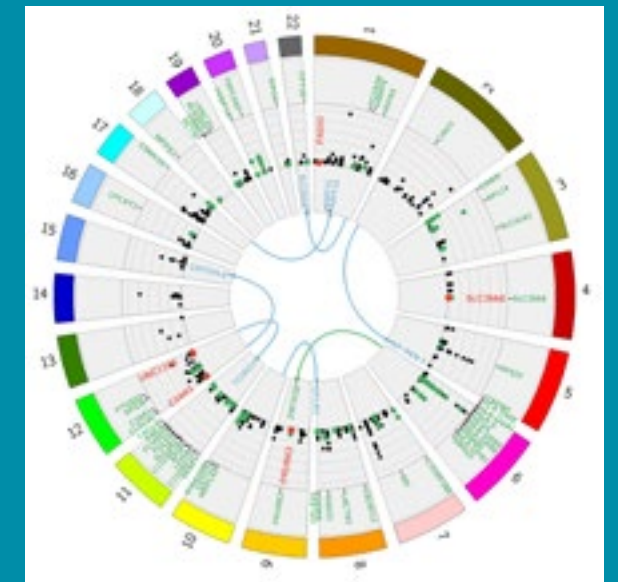
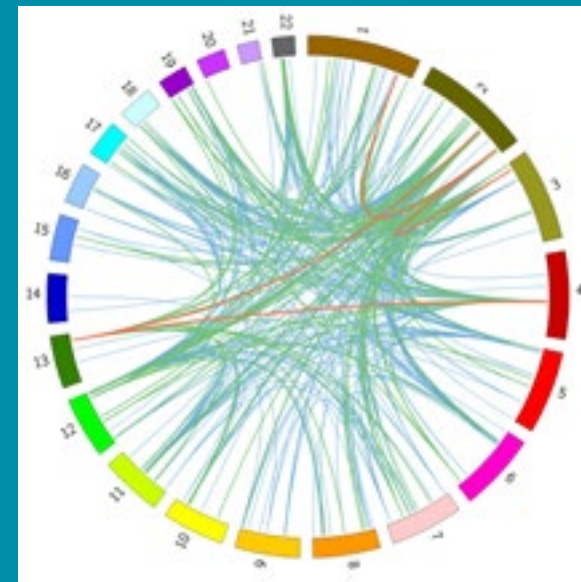
Ask Idaghdour where research such as this is going, and he speaks of the ultimate promise of “personalized” medicine: “In the US alone,” he noted, “more than 100,000 people die every year from the side effects of prescribed drugs.”

Detailed genomic analysis, coupled with a good understanding of the genotype-phenotype relationships, incorporating knowledge about environmental effects, may open an important door: it will help us to understand how each individual will respond to a given treatment — and will also help to identify prognostic markers that could predict an individual’s medical problems in advance.

And just in case all that is not enough, Idaghdour also reserves some time and energy for a related labor of love, one that recalls his early days in wildlife biology: he’s planning to collaborate with NYUAD Associate Professor of Biology John Burt in working to understand the genetic basis of thermal adaptation in corals. ▽



ABOVE: Youssef Idaghdour gathering blood samples from Berber individuals in Morocco. **BELOW LEFT:** Map of the human genome showing gene-gene interactions. Lines in red highlight interactions involving genes that modulate response to infection. Chromosomes are shown in different colors. **BELOW RIGHT:** A map of the human genome showing genes activated or silenced in response to malaria infection.



GENES PROTECT YOU AGAINST OR PREDISPOSE YOU TO COMPLEX DISEASES, WHILE THE ENVIRONMENT IS MORE INFLUENTIAL IN TRIGGERING THE DISEASE

HIGH-PERFORMANCE COMPUTING

Muataz Al-Barwani, right, associate director of High-Performance Computing and Research Computing, discusses BuTinah with a colleague.

NYU Abu Dhabi's High-performance Computing cluster, named "BuTinah" after the marine-protected archipelago reserve off the coast of Abu Dhabi, has played a critical role in supporting the computational requirements of the NYUAD research community.

Researchers in genomics, chemistry, mathematics, neuroscience, physics, and the social sciences are heavy users of the cluster for their computational needs.

NYU New York Silver Professor of Biology Claude Desplan's lab, which studies fruit fly neurons, has used the computer to manage a database that allows its researchers to compare the results from next generation DNA and RNA sequencing of the neurons. NYUAD Assistant Professor of Biology Kristin Gunsalus' lab has used BuTinah to develop computation methods for analyzing the interactions of microRNAs and their mRNA targets in atomic detail. And NYUNY Associate Professor of Biology and Computer Science Richard Bonneau's lab has published seven papers and submitted another that have utilized the computing power of BuTinah for their studies in computational biology.

The Center for Global Sea-level Change, led by NYUAD Professor of Mathematics and Atmosphere-Ocean Science David Holland, uses the computer to analyze the large sets of data his team collects from field research in Greenland and Antarctica.

With BuTinah, the Center for Prototype Climate Modeling developed models to predict future climate and tested them through extensive simulations.

Chemists at NYUAD also use the computer. NYUAD Associate Professor of Chemistry Timothy Dore's group performed docking experiments with BuTinah, during which the team computationally tested the way different molecules bond with each other. And as part of his research on "mechanically responsive materials," NYUAD Associate Professor of Chemistry Panče Naumov's lab has successfully modeled the structural and spectral properties of these intriguing molecules. Finally, in the social sciences, NYUAD Assistant Professor of Economics Samreen Malik has used BuTinah for her work on the asymmetric effects of tax changes.



SCIENTISTS DEVELOP SHARED RESEARCH METHODS AT NYUAD CORAL CONFERENCE

In the effort to develop common research methods for monitoring the health of coral, NYU Abu Dhabi Assistant Professor of Biology John Burt led a workshop in August 2013 that featured experts from the UAE, Kuwait, Australia, the UK, and the US.

"The goal was to get people all on the same page," Burt told *The National*, an Abu Dhabi-based newspaper, which reported on the conference.

A shared research method will allow scientists to effectively compare their work and will aid in the production of a comprehensive study of coral colonies throughout the Arabian Gulf. Conference papers have been published in a special issue of the *Marine Pollution Bulletin*, including an analysis of future research needs for the Gulf.

Gulf coral are of particular interest to marine biologists, as these coral live in water that is extremely warm and has a high level of salinity.

By studying Gulf coral, scientists may be able to learn how coral throughout the earth's oceans will adapt to rising sea temperatures caused by climate change.

The five-day conference consisted of two days in the classroom and three days spent examining coral in their natural habitat in the waters off Abu Dhabi.

But the conference wasn't only for marine biologists and coral experts. To bring wider attention to this important issue, Burt gave a public lecture titled "Coral Reefs of the Gulf: A Unique Eco-system." A main goal of the conference was to build awareness in the local community about threats posed to coral colonies by climate change and development.

In the future, scientists will need to work closely with developers and policy makers to preserve these unique and important ecosystems.

POLITICAL SYSTEMS AND CIVIL WAR

Over the last half century, the world has learned a great deal about how costly civil wars can be — they devastate economies, take millions of lives, and cause mass displacement. A scholar at NYU Abu Dhabi is studying the politics of civil war, and the way in which political institutions mediate social conflict more generally. His findings could hold lessons for many countries around the world struggling with violence and social unrest.

Mario Chacón, an assistant professor of Political Science, is examining several issues, starting with the way democratic reforms can prevent — or, surprisingly, trigger — armed conflict. He is also studying the specific features of democratic politics that are conducive to peace and the political legacies of war. His work also extends beyond civil wars, into the nature and dynamics of democratic institutions.

Chacón's native Colombia, a country of 48 million people, is a case study for some of his research. For half a century its government has been challenged by left-wing guerrillas, right-wing paramilitaries, and more recently, drug cartels. During the 1990s, the Colombian state launched a series of political and economic reforms, intended to reduce popular grievances and improve social conditions. One key change was fiscal decentralization: vast resources were transferred from the central government in Bogotá to regional administrations. The sum of these fiscal transfers rose during the 1990s — from 2 percent of gross domestic product (GDP) to 6 percent of GDP — so that by the end of the decade the central government was sending more than half its revenue to regional governments.

Educational outcomes, in particular, did improve. But the decentralization of resources and power coincided with a sharp increase in the activity of armed groups in the countryside. Chacón finds a robust relationship between the influx of money and the level of political murders and kidnappings, as armed groups encroached on the suddenly-well-

funded, subnational governments. Local media, too, were subverted and cowed.

Fueled by drug money, insurgent groups in Colombia hardly needed popular support. In fact, Chacón scoffed at a view still widely held outside Latin America: “The image of Latin American peasant fighters, inspired in the Cuban Revolution in the 1950s, with poor people supporting left-wing insurgencies — it may have been true then, but for Colombia and other developing countries more recently today — is not realistic.”

His research on local politics in times of armed conflict complements other fields in political science, including the subject of “political capture” — a case in which a special-interest group obtains political power for its own narrow purpose.

“In the United States and other advanced democracies, when we think of ‘political capture,’ we think of lobbying and other peaceful forms of political influence,” Chacón said. “But what happened in Colombia is a very different form of capture.” The reforms were intended to improve public confidence in the government, he noted — to win hearts and minds, to borrow a phrase — but as the regional governments came to be dominated by armed groups, the effect was the opposite.

Chacón draws a lesson from all this: “Social-welfare programs and local democracy are valuable, but if you're going to empower subnational governments, make sure this process is accompanied by a defense component ... it doesn't make sense to



Military forces of Colombia patrol territories where guerrillas of FARC remain active. Photo by Vlad Galenko

give money and resources to areas you don't control.” Moreover, the failure of decentralization to improve the security of some regions should be seen as “a red flag for US aid recipients facing insurgencies like Afghanistan and Iraq,” Chacón believes. “In fact, there is some new empirical evidence suggesting that in some contexts US aid is causally related to conflict.”

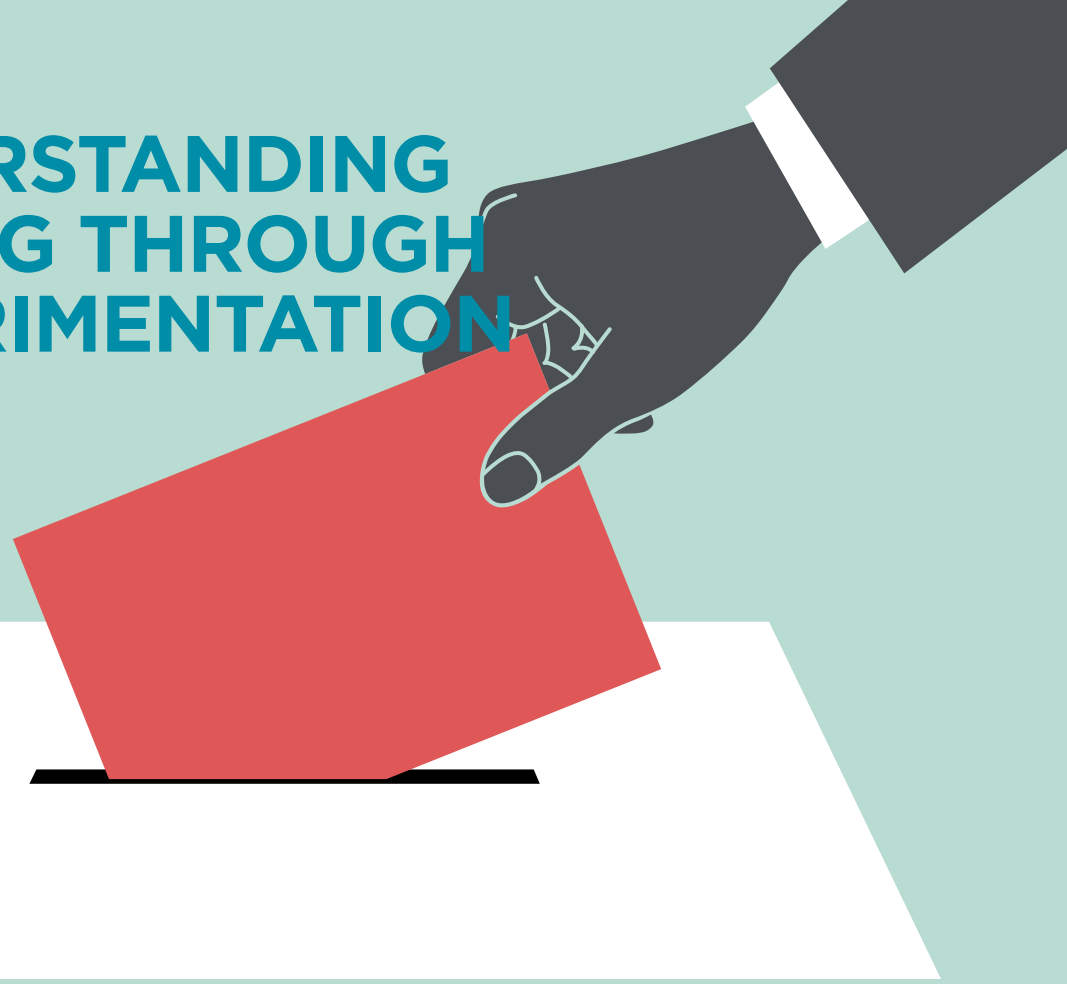
In Colombia, meanwhile, the legacy of conflict endures. Chacón is also studying, with Ana Arjona of Northwestern University, the quality of Colombia's subnational governments today. Where political violence was greatest 15 to 20 years ago, they find that corruption is highest today. Their hypothesis is that the pool of capable candidates for local office was depleted during the bloody years, as honest, capable people were killed or simply quit politics.

He also notes that today, among Colombia's neighbors, elections and other instruments of democracy serve to legitimize “increasingly authoritarian and personalistic” governments,

not only in Venezuela but also in countries such as Ecuador, Bolivia, and Argentina. Charismatic populist leaders nurture cults of personality, presenting themselves as saviors, but often seek short-term electoral gains at the expense of medium- and long-term national well-being.

Chacón also sees, however, a trend toward more genuine democracy in some countries, notably Brazil and Chile. There, local elections are becoming more competitive and democratic norms seem to be consolidating. This, as Chacón argued in his Yale dissertation, can be a precursor of more robust democracy nationally. Mexico's elite, he said, “must have known they couldn't keep one-party rule forever.” Even in Cuba, he went on, “I think the political elite there know that in the near future they will have to tolerate a minimum of electoral competition; they've started some minor reforms already.” It appears, he said, that seemingly-minor institutions such as genuine, contested local elections can propel a state toward a full transition to democracy. ▽

UNDERSTANDING VOTING THROUGH EXPERIMENTATION



By definition, scientists do experiments. Increasingly, that truism now applies to political scientists, just as it does to chemists or biologists. Rebecca Morton, a professor of Politics at NYU Abu Dhabi, is in the forefront of the development and growing recognition of this new aspect of an old discipline.

“In the last 15 years or so, many political scientists have become less and less happy with the usual observational data. It’s too messy,” said Morton, a “bridge” faculty member whose appointment is half in Abu Dhabi and half in New York.

“The gold standard in science is experiments, but we used to tell ourselves that we can’t do them in political science,” she continued. “But now we’re saying ‘maybe we can.’” Both field and laboratory experiments — practical and theoretical, in other words — are proliferating.

This approach is not altogether new; as far

back as 1924, University of Chicago scholar Harold Gosnell was assessing the effect of get-out-the-vote mailings. But such research languished until the 1970s and ’80s, when “the increase in cheap and easily programmable computer networking technology” jump-started the field, Morton suggested in a 2006 paper with Kenneth C. Williams of Michigan State University.

Since about 2000, growth has accelerated: in 2010 the American Political Science Association added an experimental research section, underlining the field’s growing maturity and acceptance within the discipline. The new section has its own

fledgling journal, of which Morton is a co-editor. As president-elect of the section, she will take office when her editorship ends.

At NYUAD, Morton is director of the Social Sciences Experimental Laboratory (SSEL); in January 2014 the SSEL held an inaugural Winter Experimental Social Sciences Institute.

Morton’s own work focuses on voting experiments. In a controlled setting — a “laboratory” — subjects are told the rules of an “election” that is purely imaginary, except for the cash payouts: You favor candidate A. If A wins, you’ll be paid \$25, but supporters of B will get just \$5. If B wins, every voter gets \$20. Under these conditions, will A’s supporters make the “ethical” choice to maximize total payoff and minimize inequality?

The work goes far beyond this simple example: multiple candidates, simulated opinion polls, imposed “campaign spending” effects, majority requirements, runoffs, and voter groups of up to 1,000 can all add complexity.

“Lab in the field” projects add specificity. With colleague Xiangdong Qin of Shanghai Jiao Tong University, Morton is supervising lab-type “voting” by Tibetan students at Southwest University for Nationalities, in Chengdu, China. These studies examine coalition-building and willingness to support an ethnic Chinese candidate in a local election that also involves a Tibetan candidate. In this study participants can discuss the question among themselves before “voting.”

Morton is also planning to measure differences in theoretical voting behavior among Muslim populations in three culturally-different areas: northern China, Malaysia, and the UAE.

Experiments that permit consultation among subjects, she noted, are not about “voting” in the narrow election-day sense, but rather involve “deliberative group decision-making.” That subject resonates in the UAE and any place that seeks good governance but does not have Western-style electoral democracy.

Anyone who follows Western politics understands that voter behavior is complex, involving many factors beyond a nominal total

payoff. Morton acknowledges that her approach offers no absolute answers. “We’re trying to isolate one particular mechanism,” she said, “abstracting away from all the other things going on in an election. We can learn something by isolating certain factors. That doesn’t mean the other things aren’t important. Other political scientists are looking at candidates’ personality factors, facial appearance, and smiles and the like.”

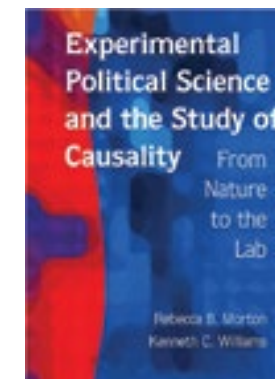
Like any new field, experimental political science has its challenges, and “there are still people in the political science community who are skeptical,” she conceded.

Real elections provide a wealth of data, and many scholars are consulting with political parties, in the US and other countries, Morton noted. But “I don’t do that kind of stuff,” she said, largely because “parties don’t want to randomize” — if they send a mailing, for example, they intend it for every voter, depriving a researcher of any control group.

Some political science experimenters come from psychology, some (including Morton herself) from economics, some from statistics, and so on. Among these groups there are, she said, “arguments about what methods are best but I prefer to think these are all complementary.”

Another issue in the community is the use of deception in experiments. Subjects may be shown a fake *New York Times* article, for example, to see if it changes their perception of a political issue. Morton is wary: “As experiments become more widespread, the more we do this kind of deception the more subjects will be wary of us.”

Any new field has growing pains, but the growth is undeniable. “The way I see this,” Morton sums up, “is that it’s very much research in progress. We’re doing one little piece ... later we can work on putting all the pieces together.” ▀



FOLLOW THE DIGITAL FOOTPRINTS

It's a contemporary cliché in almost every field of endeavor: we're drowning in data. From the simplest Google search, to the most recondite statistics for scholars, the new flood of information must be filtered and channeled and managed.

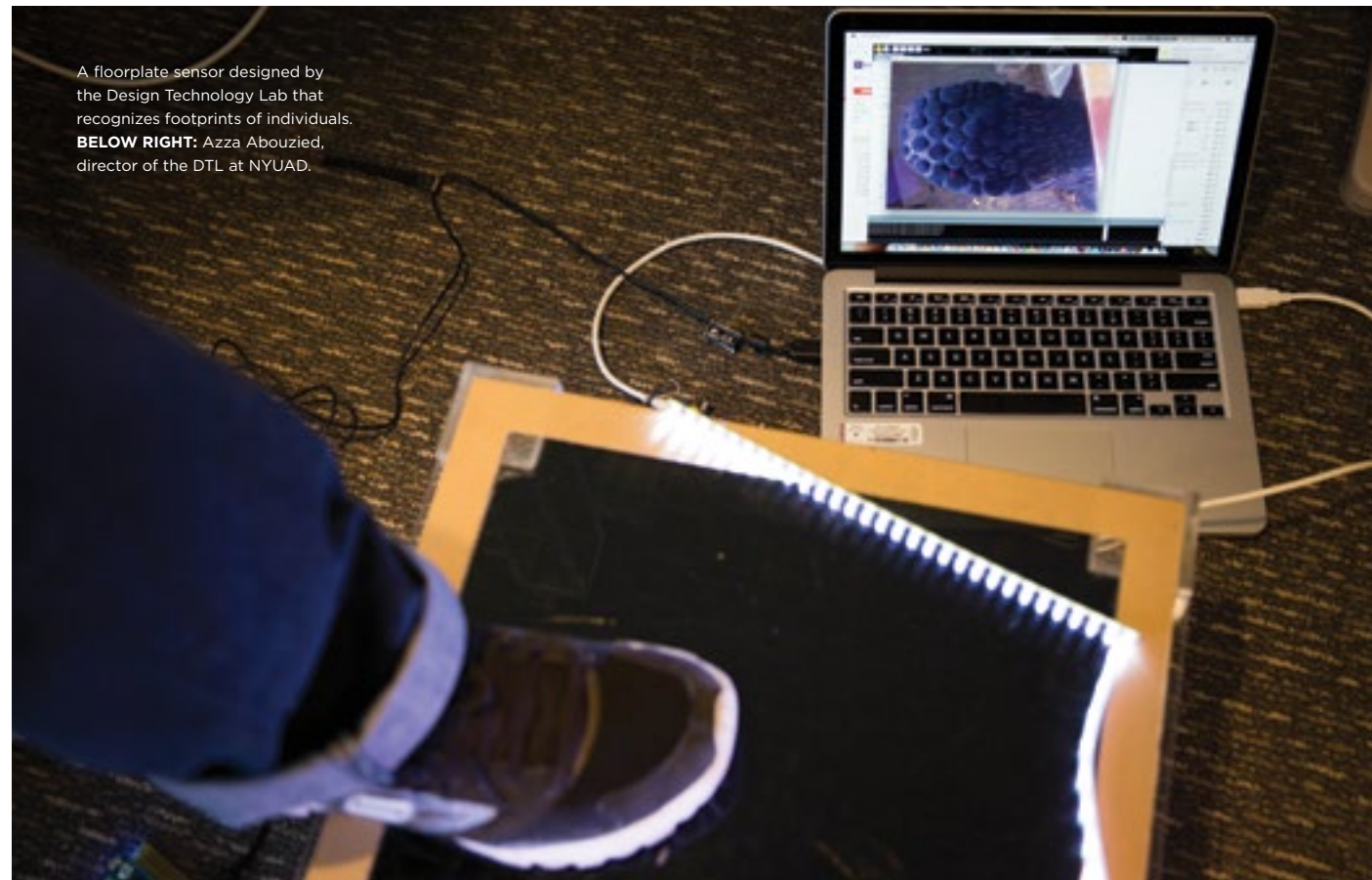
Enter the “data scientist.” That's what Azza Abouzied, an assistant professor of Computer Science, calls herself and her colleagues at NYU Abu Dhabi's Design Technology Lab (DTL). “We want,” she said, “to make it simpler for ordinary people to use their data.”

That effort is leading the DTL to some interesting places — including the UAE's iconic shopping malls. Under the title of “mall science,” Abouzied and others in the DTL are working on helping shoppers navigate through enormous, confusing malls.

Abouzied, born in Bahrain to Egyptian parents, grew up in Dubai, where an A-level computer-science course in her British-system secondary school sparked her interest. After earning her Bachelor of Science and Master of Computer Science degrees at Canada's Dalhousie University; she received her Ph.D. from Yale University in 2013.

Through those years she grew increasingly aware, she said, that although data abounds, for any given problem “the amount of relevant data is actually tiny. We can make the machines go faster, but the people using the data need help.” Her approach is to “ask people to tell us what they need from the data, and then we build the software tools to let them do that.”

She offered a simple example: if a car salesman wants to know what color is most popular in, say, Dubai, he can hire people to count vehicles on the



streets. But geo-spatial data processing might be simpler and faster — summon up Google satellite photos, scan them for vehicle shapes, tally those up by color, and extrapolate. In India, she said, urban poverty is being assessed by satellite-photo identification of the building materials used for roofing.

But such efforts demand “very sophisticated programs,” she said, because “the process is not intuitive ... you can't use natural language, since there are ambiguities.”

For these methods to become widely useful, she said, they must first become simple. “We want anyone to be able to pull up Google Maps or some other map data and get what they want using our tool.” She calls it an “inference machine.”

Then there is PackageBuilder, software Abouzied developed with three colleagues from the University of Massachusetts before she arrived at NYUAD. Any search engine can provide a list of, say, gluten-free



recipes. But imagine asking for, and getting, a seven-day, 21-meal gluten-free menu — limited to 2,200 calories a day. PackageBuilder extends the familiar SQL programming language to allow such searches.

There is also DataPlay, another pre-NYUAD project of Abouzied's. This is a system for querying a database and getting responses as clear data visualizations — graphs, for example — that can then be fine-tuned or amended as needed via a touch-

screen. The goal, she has said, is “more friendly and interactive query components.”

While DataPlay is mainly theoretical, she said, PackageBuilder has more immediate practical possibilities, and so offers interesting commercial prospects. “Whether it's buying from Amazon or building an exercise plan, people want to be able to build packages,” she said. With UMass, she's hoping to proceed with a three-year project to develop PackageBuilder.

The DTL, meanwhile, is moving ahead with CommonTies. Imagine registering for a conference and being given a wristband with a microchip and a tiny light-emitting diode. This lights up whenever you are in the same room with someone with whom you share research interests, have attended the same sessions, or have some other connection. Big data makes that possible, as the DTL's prototype is demonstrating. There are non-academic applications, too, wherever people gather.

Abouzied says the DTL is in part modeled after the Massachusetts Institute of Technology's celebrated Media Lab, in tackling projects that offer “magic, impact, and real work” — that is, each effort must provide a “wow factor,” have social utility, and involve a genuine advance.

That's where data science goes to the mall. Imagine stepping onto a computer-linked floorplate and asking a touch-screen for directions to a given shop. Instead of a complicated route on a hard-to-grasp diagram, you're given just a general direction. At the next intersection you step on another plate — and it recognizes you, and steers you onward. You repeat until you find your destination.

We all “naturally emit” so much data, Abouzied said, that this is possible. The sensor plate could recognize your foot pattern, your smartphone's digital signature, even your weight, and combine these to identify you and keep steering you the right way.

For the DTL team, led by Abouzied and Jay Chen, also an assistant professor of Computer Science, efforts like these are just the start. A decade from now Abouzied hopes DTL will be a cosmopolitan Middle Eastern hub where people from all over can come to design, build, and test diverse projects of real use. ▀



HOUSE OF TWEETS: US CONGRESS, PERSONALITY, AND SOCIAL MEDIA

Observers from across the political spectrum agree on one thing: the US Congress is too often victim to polarized partisan gridlock. No doubt these are contentious times in Washington, DC. But how did Congress get this way?

The prevailing narrative argues that today’s legislators do not cooperate because they are more ideologically extreme than their predecessors. Republicans are more conservative, Democrats are more liberal, and this ideological polarization leaves little shared ground on which lawmakers can work together.

But Professor Adam Ramey wonders if change of another kind has also taken place in Congress. “While I think there is something to the ideological argument, I also think it is a bit circular,” Ramey said. “So we’re trying to use a personality paradigm, not to displace the role of ideology, but to explain more.”

Ramey, an assistant professor of Political Science at NYU Abu Dhabi, is interested in the way legislators make decisions, and how elections, laws, and other constraints affect legislative behavior. “I’m trying to disentangle the way legislators’ own policy priorities, the wishes of their districts, and the wishes of their parties, all come together and lead to the results we see in Congress,” he explained. His current book-length project draws on psychology and computer science, as well as political science. The venture may provide a new explanation of how personality is increasing polarization in Congress.

Ramey raises the example of two Republican senators who are ideologically similar, but very different in legislative behavior: Marco Rubio of Florida and Ted Cruz of Texas. Both are conservative, both are of Cuban ancestry, both are young, energetic, and well-educated, and both were

elected with strong Tea Party support. But they behave quite differently. “Ted Cruz will filibuster on the Senate floor and block legislation proposed by Democrats,” Ramey noted. “Rubio, on the other hand, is much more willing to play ball ... to work towards a common goal.”

There are many theories of personality, but the most widely-accepted one identifies five dimensions of personality, called the Big Five, known by the acronym OCEAN — Openness to new experiences, Conscientiousness, Extroversion, Agreeableness, and Neuroticism. Each is a spectrum: a person may be extremely extroverted, or extremely introverted, but most of us are somewhere in between.

Computer scientists have developed techniques to analyze individuals’ language and use what they find to assess OCEAN-based personality. For example, it turns out that people who use the personal pronoun “I” frequently tend to be more extroverted than people who do not.

Using these findings, his team will assess the language used by all 535 members of the House and Senate — speeches, press releases, and tweets, for example— to create personality profiles for each member of Congress. Legislators will get a “personality score” for each year they have been in Congress. The findings will show how the personalities of individual legislators have changed over that period and how the composite personality of Congress has changed, too.

This is where the political science comes in. The researchers will then compare legislators’

SUMMARY OF THE BIG FIVE PERSONALITY TRAITS

PERSONALITY TRAIT	MINI-MARKERS	PARAMETER(S)
Openness	creative, imaginative, philosophical, intellectual, complex, deep, uncreative, unintellectual	loss aversion; risk preference
Conscientiousness	organized, efficient, systematic, practical, disorganized, sloppy, inefficient, careless	time preference
Extroversion	talkative, extraverted, bold, energetic, shy, quiet, bashful, withdrawn	expected utility of uncertain payoff(s)
Agreeableness	sympathetic, warm, kind, cooperative, cold, unsympathetic, rude, harsh	social preference
Neuroticism	moody, jealous, temperamental, envious, touchy, fretful, unenvious, relaxed	accuracy of priors for uncertain payoff(s); locus of control

“OUR INTUITION SUGGESTS THAT PART OF THE REASON WHY WE OBSERVE SO MUCH CONTENTION IN CONGRESS TODAY, WHY WE OBSERVE SO LITTLE COLLEGIALITY AND SO MUCH CONFRONTATION, IS THAT THE PERSONALITY OF CONGRESS IS CHANGING”

personality profiles to their Congressional behavior. Do they co-sponsor bills? Do they habitually vote against legislation proposed by the other party? And so on. Comparing the two sets of data will show if there is any correlation between personality type and legislative behavior.

Over the past 17 years, Ramey and his team have identified shifts in the personalities of members of both the House and Senate. They have noticed a decline in both conscientiousness and openness to new experiences. Legislators have also become more extroverted, and “the correlations between extroversion and ideological polarization is extremely strong,” Ramey said. “Our intuition suggests that part of the reason why we observe so much contention in Congress today, why we observe so little collegiality and so much confrontation, is that the personality of Congress is changing.”

The project began as an investigation of voters, not legislators: do voters choose candidates with a certain personality type? But even if they do, it’s not clear why that would matter very much. So

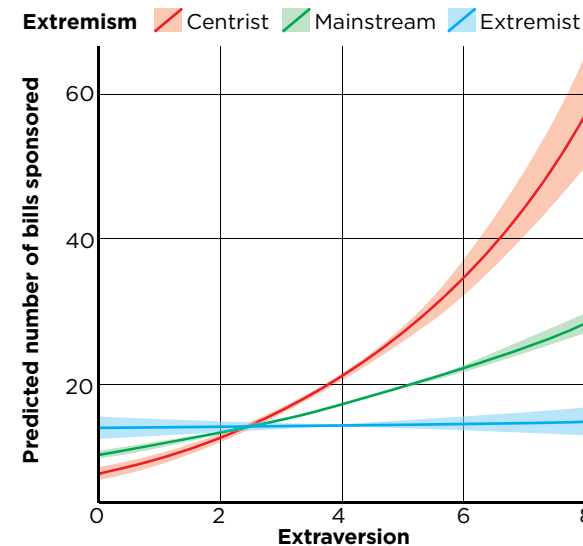
Ramey decided to start at the other end of the issue, “to determine if personality traits matter for how legislators make legislative decisions. And once we had firm grounding there, we could say, ‘Of course voters should care about the personalities of the people they elect, because personality determines how legislators make decisions.’”

In the future, he is interested in building tools to help voters gain a better understanding of candidates. Imagine an app which could suggest local candidates who match your political beliefs and personality type. This would be particularly helpful for “down-ballot” races, for offices such as city councilor or sheriff, where it may be hard for voters to learn about candidates.

Ramey’s work, with its potential to help us better understand congressional performance, is clearly important. “In the last couple years,” Ramey said, “I’ve been to Thailand, I’ve been to Finland, I’ve been to France. And everywhere I go, people talk about the US Congress. And not in a good way ... there are a lot of problems in Washington.”

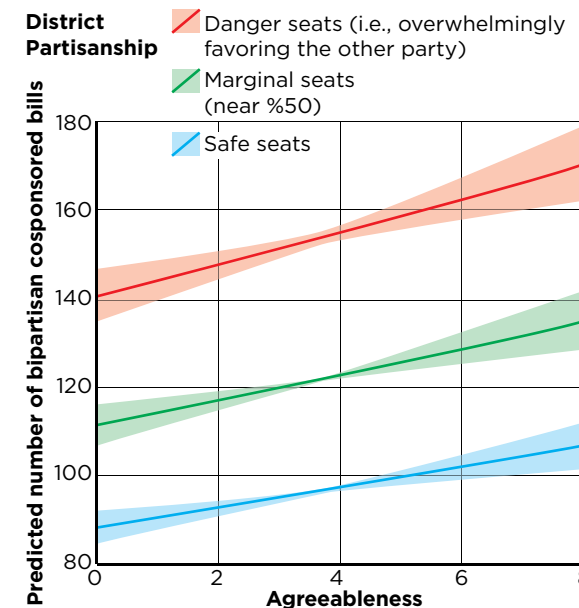
Predicted number of bills proposed

The predicted value plot fixes all parameters but extroversion and extremism at their means. Ideological extremism is varied from its minimum value 0 to its median (0.4) and 99th percentile (0.8). Point estimates are represented by solid lines and 95% confidence intervals are shaded.



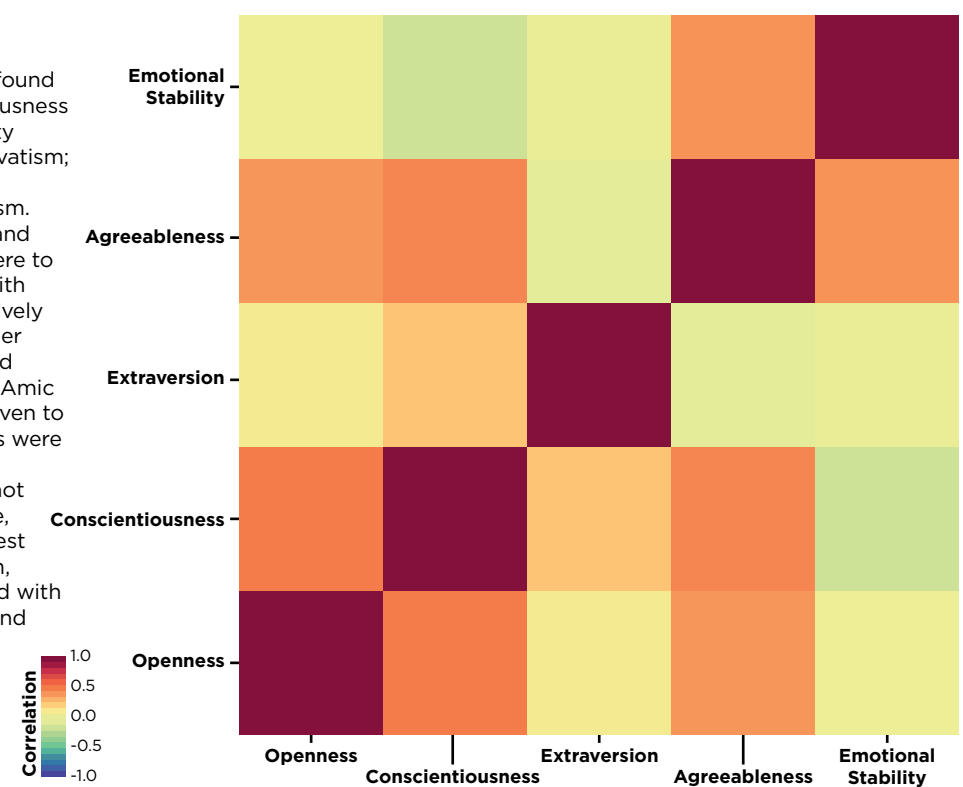
Predicted number of bills proposed

The predicted value plot fixes all parameters but agreeableness at their means. Point estimates are represented by solid lines and 95% confidence intervals are shaded.



Intra-Big Five Correlations

Ramey and his team found that both conscientiousness and emotional stability correlate with conservatism; the other three traits correlate with liberalism. If conscientiousness and emotional stability were to positively correlate with each other but negatively correlate with the other three traits, that would suggest that the DYNAMIC PERSONALITY scores given to members of Congress were simply replications of ideology. But that is not the case. For example, openness, the strongest predictor of liberalism, is positively correlated with both agreeableness and conscientiousness. Similar findings hold across other traits.



Source: “More than a Feeling: Personality and Congressional Behavior” by Adam J. Ramey, Jonathan D. Klinger, Gary E. Hollibaugh

MIGRANT LABOR EXPERIENCE IN THE UAE

In sociology and political science, Ivan Szelényi notes, immigration is “a gigantic field of study.” And in the UAE, the immigrant majority is vital to the economy. So when this distinguished sociologist was seeking a subject for new, UAE-related research, this issue caught his interest.

Szelényi, dean of Social Science at NYU Abu Dhabi, has had a long and varied career, much of it about social and financial inequality, including study of the Roma of Central Europe — “as poor as you get,” Szelényi said. His book *How to Become a Billionaire* — published so far only in his native Hungarian — examines the sources of great fortunes in Central Europe, Russia, and China.

But here in the UAE, he said, “the big issue is migrant labor. So I became interested in that.” In particular, he wondered why the UAE’s laboring population enjoys such racial and sectarian peace, in a region known for neither. Is this due solely to the UAE’s immigration policies, or could it be that “living in a multi-cultural environment may actually improve tolerance”?

In the spring of 2011, Szelényi and a Pakistani friend and colleague began working out a way to test that latter hypothesis. He and Riaz

Photo by Alberto Manca





Photo by Philip Cheung

ALMOST 90 PERCENT OF RETURNERS SAY THEY CONSIDER THEMSELVES TO BE UPPER-MIDDLE-CLASS, OR EVEN UPPER-CLASS. SZELÉNYI NOTES THAT WHILE THIS IS LIKELY AN OVERSTATEMENT, IT SHOWS THAT WORKING ABROAD IN THE UAE ... NOT ONLY AFFECTS INCOME, BUT ALSO UPWARD SOCIAL MOBILITY

Hassan, emeritus professor of Sociology at Flinders University in South Australia, were aided by the respected Institute for Social Research in Lahore. The two men designed and supervised a study in which some 250 workers about to leave Pakistan for jobs in the UAE were interviewed, as were 250 who had recently returned from this country (after an average stay of 4.5 years). Respondents were asked about their attitudes toward Pakistanis of other ethnic groups, toward people of other nationalities such as Indians, and toward people of different faiths.

This was, Szelényi said, the largest such study ever done about the UAE. (Previous work has lumped the Arabian Peninsula monarchies together, and so findings are naturally weighted towards the more populous Saudi Arabia.)

Szelényi's monograph will not be finished until mid-2015. "We are still crunching the numbers," he

said, "and we've just started to get the multi-variate analysis, and we have long interview texts to read." But already, he said, the data is providing insights.

On the main goal of the study, to understand diversity and tolerance, the findings so far are encouraging. About 70 percent of returners to Pakistan from the UAE said their attitude toward other Pakistani groups had improved, and 40 percent said they were better-disposed towards Indians. Some even said they would prefer an Indian to a Pakistani work supervisor.

But on less-abstract "social distance" questions — such as "would you mind working with a Pashtun?" and "would you have an Indian friend?" and "would you be content with your daughter marrying a Hindu?" — the interviews revealed little difference between those about to arrive in the UAE and those who had returned.

There are also other factors to consider, he noted.

The returners are of course older than the new recruits, and greater maturity may have affected their attitudes. Also Pakistan has, despite its well-publicized problems, been improving its education system as the population becomes more urban, Szelényi said. So the next cohort of Dubai laborers and Abu Dhabi cab drivers may be expected to arrive in the UAE with a somewhat lower level of prejudice than previous ones. "As usual in social science," Szelényi said, "there is no simple answer."

The study does however illuminate some little-understood aspects of the migrant labor experience. The workers here send half or more of their incomes home to support families, and while those incomes are slight by western standards, they are typically four times what the migrants could earn in Pakistan. The length of stay was also of interest: with an annual visit home, married laborers may, if they stay here too long, find themselves with large

families to feed in Pakistan, so that they are in effect trapped here to support their growing families. "The smart ones go home before it's too late," Szelényi said.

And when they return home, they typically find that they have benefited from having worked in the UAE. Unemployment is high in Pakistan, even for returned workers, but many have been able to start small businesses. And quite a number have found brides: only 30 percent of those bound for the UAE are married, while 75 percent of returners are.

And, strikingly, almost 90 percent of returners say they consider themselves to be upper-middle-class, or even upper-class. Szelényi notes that while this is likely an overstatement, it shows that working abroad in the UAE for a period of time not only affects income, but also upward social mobility. That means the supply of workers bound for the UAE is not likely to dry up anytime soon. ▽

TEACHING EMIRATI ARABIC AT NYUAD

It sounds more like a calendar of extra-curricular activities than a credit course. Nasser Isleem's intermediate and advanced students learn Arabic not only in the classroom but through lively immersion in Emirati culture: an evening of falconry (and barbecue); home stays with Emirati families; study of Emirati proverbs and fables; wheelchair basketball with disabled Emiratis; screenings of *Sea Shadow* and *Freej* (respectively an Emirati feature film and a Dubai-made TV cartoon); and more.

The emphasis on Emirati ways and traditions is no coincidence. Isleem's students are learning not Modern Standard Arabic (MSA), but rather the distinct Emirati dialect, in which, for example, "marhaban," the MSA word for hello, becomes "marheba-ssaa."

Isleem, a senior Arabic language instructor at NYU Abu Dhabi, has literally written the book on this: his textbook on the subject, written with Emirati co-author Ayesha Al Hashemi, is to be published soon, under the title *Ramsah*, which means "Emirati talk." Parts of it have already been used for his first class in Emirati Arabic, in January of 2014.

Arabic is the sixth most-spoken language in the world, but it might be more precise to say "Arabic are." The language has at least four major dialects, Isleem explained. MSA is the norm in published matter, but spoken Arabic is increasingly diverse. The Levant speaks a version called Shaami; in North Africa there is Maghrebi Arabic, tinged with French; the Egyptians have their distinctive version; and then there's the Gulf dialect, of which Emirati Arabic is a main component.

Choosing among these is always a point of argument when Arabic-language instructors convene, Isleem said. "Some say it should be only MSA, some say start with dialects," he noted. "Everybody claims their dialect is closest to MSA," he added, laughing.

Now, though, the dialects are getting a foothold in academia. "It's something pioneering, in the last few years."

At NYUAD, the Emirati Arabic class is open only to students who have taken at least three semesters of MSA; the first session enrolled seven students. The cultural adventures are noteworthy, but the course is grounded in rigorous academic work. It includes three morning hours in the classroom each day, then an hour of discussion, and other activities in the afternoon or evening. "We make sure they have a balanced load," Isleem said. "The academic part is essential."

Integrating cultural awareness and experience always improves language acquisition, Isleem said. "Students learn better. Seeing how people live triggers the students' interest."

It is an approach he discovered while teaching in North Carolina. As a Palestinian who grew up in refugee camps in Gaza — his parents still live in the troubled territory — Isleem was able to go to America to study, earning a master's degree in educational management; his thesis was on integrating culture into teaching.

He found work teaching MSA at the University of North Carolina at Chapel Hill (UNC), at Duke University, and at nearby Meredith College. The title of his first book, *Popular Proverbs: An Entrance to Palestinian Culture*, reveals his approach.

He has also found ways to get his students out of



Nasser Isleem taught a class in Emirati Arabic in January 2014 that gave NYUAD students an intensive cultural immersion experience in Al Ain. For three weeks, students spoke only in Emirati Arabic while they participated in local cultural activities, such as falconry, home stays with local families, and film screenings.

the classroom, from Iftar evenings during Ramadan to restaurant events where students can meet local Arabs over cardamom coffee while an oud player performs. In North Carolina, a friend loaned his farm for an annual "Arabian village," where Arab residents of the area would present their various national arts, food, and attire, in "an atmosphere full of harmony and fun."

His classes boosted cultural understanding, and grew steadily in popularity. UNC gave him its prestigious Golden Fleece Award, noting that "his colleagues recognize him as a driving force" in developing the school's fast-growing Arabic program.

In 2012 he came to Abu Dhabi to be closer to his parents, to be sure his own children learned MSA as

well as the Palestinian dialect, and to "explore the wonderful opportunity of teaching at a prestigious institution like NYUAD." Here he soon saw that an Emirati-dialect class would make sense. With just MSA, "students were having a difficult time using the language outside the classroom," he noted. One American student even chose to wear a sign: "Speak to me in Arabic." But being able to talk to Emiratis as they talk to each other is even better, Isleem said.

Publication of *Ramsah*, by the Emirati house Kuttab Publishing, is awaiting completion of illustrations, and of audio recordings for the CD. (The voices are provided by Emirati students at NYUAD.) Once the book is out it will be available to expatriates, language schools, and anyone else eager to learn the flavor of this country's Arabic. ▀

THE ILLUSIVE WHOLE THEATER MOMENT

In theater there are rare moments when something electric happens, so that people in the audience are suddenly fully engaged — “visually, aurally, intellectually, emotionally, and spiritually,” as Rubén Polendo puts it. Those “whole theater” moments, as he calls them, are the goals that inspire his work.

The Mexican-born associate professor of Theater at NYU Abu Dhabi has connected Theater Mítu, his New York-based performance company, with his work at NYUAD, creating novel forms and methods of performance and teaching alike. Some of his approaches can be dizzying — using inanimate objects to portray certain characters in *Death of a Salesman*, for example — but his results are impressing both university audiences and the wider theater community.

In March of 2014, Polendo presented *Juárez: A Documentary Mythology*, at NYUAD. In the hands of his Mítu actors that phrase “documentary mythology” makes sense: The documentary is a form, and myths are the stories we use to help us explain the world to ourselves.

Juárez, the Mexican city on the Texas border where Polendo was raised, needs some explaining: it has had the world’s highest murder rate. Polendo’s production combines factual history, personal memory, and excerpts from about 300 hours of interviews with residents. The Mítu actors are “not performing those texts, but theatricalizing them,” he said, and even “musicalizing” a few of them, in “minimalist songs,” all to explain the city’s ordeal. One interview subject — the professor’s father Rubén Polendo Senior, as it

happens — says “the story of Juárez is the story of every city that’s been abused by progress.”

Theater Mítu is in residence at NYUAD; the actors in Polendo’s annual Abu Dhabi productions are Mítu professionals, but as many as 40 NYUAD students apprentice with him and the troupe on each project. “To view the interactions involved in the professional work we do here gives the students a lovely vantage point,” he said.

And they learn a lot, because everything done by Mítu draws on many cultures; it is no coincidence that “mítu” is a word with many meanings in at least five languages.

Mítu performers are also researchers, who broaden their art by studying theatrical

forms, mainly in India but also in Thailand, Japan, Mongolia, Singapore, Bali, Nepal, Sudan, Chile, Yemen, Oman, Mexico — and the UAE. Each Mítu production draws on some of these sources.

And the troupe’s works are seen internationally: *Juárez*, for example, opened in the city it is named for, then played in New York in January 2014, and in Beirut before coming to Abu Dhabi, and was scheduled to play in Cairo next.

The piece, Polendo said, is “not purely aesthetic, not purely intellectual, not purely historical. It’s all those things, and more.”



Rubén Polendo's *Juárez: A Documentary Mythology* performed by Theater Mítu.

Photos by Justin Nestor



Polendo takes advantage of the close proximity of India to the UAE for his field research. Photos by Justin Nestor



“TRADITIONALLY, AUDIENCES ARE OFTEN ROBBED OF A VOICE. BUT HEARING FROM THEM IS ALSO PART OF THE RESEARCH”

Another characteristic of Mitu’s work is follow-up: typically audiences are invited to stay for discussion after performances, or attend a subsequent meeting. “If they take time to do that, you know they’re interested,” Polendo said. “Traditionally, audiences are often robbed of a voice. But hearing from them is also part of the research.”

Mitu’s cross-cultural study increasingly includes this region; a new piece is being developed with a Lebanese performer/writer and Lebanese visual artist, for example. “But India continues to be central to my research,” Polendo said. “I’m very grateful that it’s only a two-or-three hour flight from here.”

“The relationship with a research university is a great advantage,” Polendo said. “We fit in very well because the Mitu approach is always to go from

theory to research to production.” One semester, he recounted, “I had two science students in my introductory class. They were nervous at first but they became more at ease as they recognized that it was a laboratory setting; we do research that allows you to question the form” and the status quo, just as physical scientists do.

After *Juárez*, Polendo is moving on to Hamlet, or rather ur-Hamlet. “There were stories like Hamlet before Shakespeare wrote his play; we understand that he drew heavily on them. These are referred to as ‘ur-Hamlet,’” Polendo said, using a term for a first version of something.

“Now in our production we will use Shakespeare’s play as our ur-Hamlet. Just as the original ur-Hamlet has been shattered by time, so we’ll be shattering

the Shakespeare version, making it into shards and re-assembling them.

“On this production,” he continued, “we’ll be working with mohiniattam, a classical dance form, and kalaripayattu, a martial art, both from Kerala, and with butoh, a Japanese dance theater form. And if that isn’t enough, we’re also planning to transpose the genders of Hamlet and Ophelia.”

Confused yet? Polendo is quick to be reassuring: “The challenge will be to bring these ideas together in a way that reveals something new about Hamlet and about the questions Shakespeare raises in these texts. Shakespeare can often make an audience feel intimidated. We want this show to be engaging and meaningful to our audience, and above all to make an impact.” ▾

AT THE INTERFACE OF MATHEMATICS AND PHYSICS

In the higher reaches of physics, says Federico Camia, the border with mathematics has become remarkably porous. And he is living proof of that: holder of a Ph.D. in physics from NYU, he is today a visiting associate professor of Mathematics at NYU Abu Dhabi.

Camia's work in theoretical statistical mechanics focuses on systems such as the Ising model, a way of thinking about ferromagnetism. Named after 1920s German physics student Ernst Ising, this is perhaps the most-studied model of statistical mechanics, said Camia. And now the Ising model is yielding important new insights, thanks to the use of recently-developed mathematical tools.

"I study stochastic models with a spatial structure," Camia said. That is, he is interested in "both randomness and geometry."

If those sound mutually exclusive, consider that probability theory began as the study of single random variables. But "things have evolved. One of the most interesting fields of modern probability theory is the study of not just random numbers but random geometric structures: systems made up of many components that interact randomly with each other, in a way that depends on how they are arranged in space. That requires an interplay between geometry and randomness," Camia said.

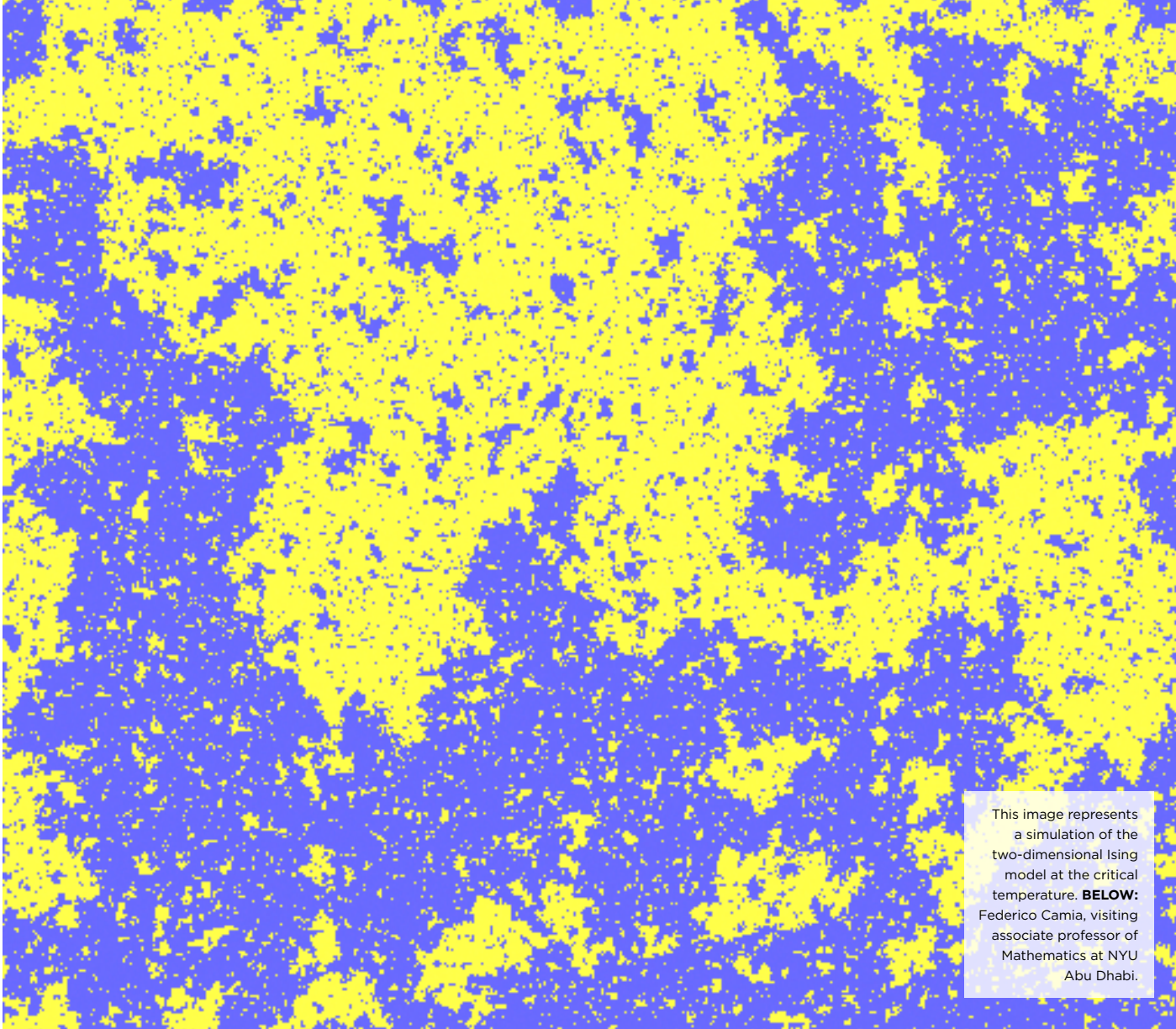
To explain, he cites percolation, referring to the way fluids filter through a porous material, like water moving through coffee grounds. The process is not regular, so developing a model to describe it

is a challenge. One way is by starting with a regular structure of channels, organized as in a lattice. Randomness is then introduced by deeming each channel to have a given probability of being closed. The process of percolation reveals that at a certain critical value of that probability, a startling phase transition occurs. Camia offered an analogy with water: at critical points of temperature, water changes from solid to liquid to gas. Similarly, as the density of closed channels increases, at a certain point, the probability that water will permeate a porous material completely will suddenly jump from almost one to almost zero.

Camia's research seeks to explain the behavior of the whole system at one of these critical points.

"Systems at or very near the critical point have special properties," he said, "properties they share with certain systems from particle physics and quantum field theory. There's not an obvious physical connection, but the mathematics you need to model these two subjects is the same."

This has been known for a long time, but today "new mathematical tools have proved very useful," he said, producing new results so that "we start to understand a lot more." This realization has



This image represents a simulation of the two-dimensional Ising model at the critical temperature. **BELOW:** Federico Camia, visiting associate professor of Mathematics at NYU Abu Dhabi.



galvanized scholars around the world, he adds. In 2006 and again in 2010, the International Medal for Outstanding Discoveries in Mathematics, known as the Fields Medal, was awarded in this subject area. One such new tool is an equation that describes random fractal curves with very special properties that seem to characterize two-dimensional systems at the critical point.

At the critical point, Camia goes on, a system acquires a new symmetry known as scale invariance: if one takes a portion of the system and blows it up to the same size as the whole, it looks just like the whole system. Exploiting this fact (in the opposite direction), one can study scaled-down versions of a system, and as the system becomes denser — its points closer together — "you get a continuum, and it has fractal properties, so that brings in the mathematics of fractals ... it's quite amazing that physics turns out to be described by mathematical language that many of us find quite beautiful."

Working at the interface between mathematics and physics brought Camia to a fruitful partnership in 2013, when for a semester at NYUAD he was able to work with two visiting scholars, Matthew Kleban, NYU New York associate professor of Physics, and Alberto Gandolfi, a professor of Probability and Mathematical Statistics at the University of Firenze, Italy. The three joined forces to work on a problem in cosmology and mathematical physics, Camia recalls. He has been busy editing the paper they wrote.

He believes that in many fields there is much to be accomplished and discovered at the places where one field of knowledge meets another. "It is unfortunately true that we can tend to work in silos," he acknowledges. "As we get more specialized, problems become more complicated and so do the tools we use; it takes time to learn new tools.

"So cross-pollination is not easy. Once you become an expert in something, it can be a temptation to just keep using the tools you've learned to make incremental progress. But as you find out more, there are new questions that arise, and you realize there are connections with other fields." ▾

VIRTUALIZATION OF TOUCH

Mohamed Eid lights up with enthusiasm as he expounds on the future of “tangible interfaces.” No wonder: from computer gaming to wheelchair control, his work promises to expand users’ computer experiences beyond the keyboard and screen, beyond just sight and sound, to touch, gesture, and more.

Eid, an assistant professor of Electrical Engineering at NYU Abu Dhabi, is working with associates on a sheaf of projects in computer haptics (from the Greek word for touch), a field that offers vast commercial potential while also promising enormous social utility. Consider the “HugMe” jacket: vibro-tactile actuators are inserted into the garment and are controlled by computer; the wearer can feel a remotely-applied touch, hug, or even “gunshot” — an example of “affective haptics.”

The Lebanese-born Eid’s interest in haptics began during his Ph.D. studies and early teaching days at the University of Ottawa, Canada. Aware that engineers must solve problems in many different fields, he took an interest in, among other things, physical therapy for stroke victims at Ottawa General Hospital.

Many such patients lose their understanding of kinesthetic interaction: they would often, for example, either drop or crush a soft plastic cup in trying to pick it up. That sparked Eid’s curiosity about the sense of touch, which he noted is “very rich in terms of how much information and energy we exchange,” usually unconsciously. For an electrical engineer, the next step was naturally the new field of haptics.

Today, sight and sound are the “dominant modalities” in users’ computer experience, but soon, Eid said, touch will be dominant in some uses.

In the slingshot game he has developed, for example, you grasp a ball-like device and move it

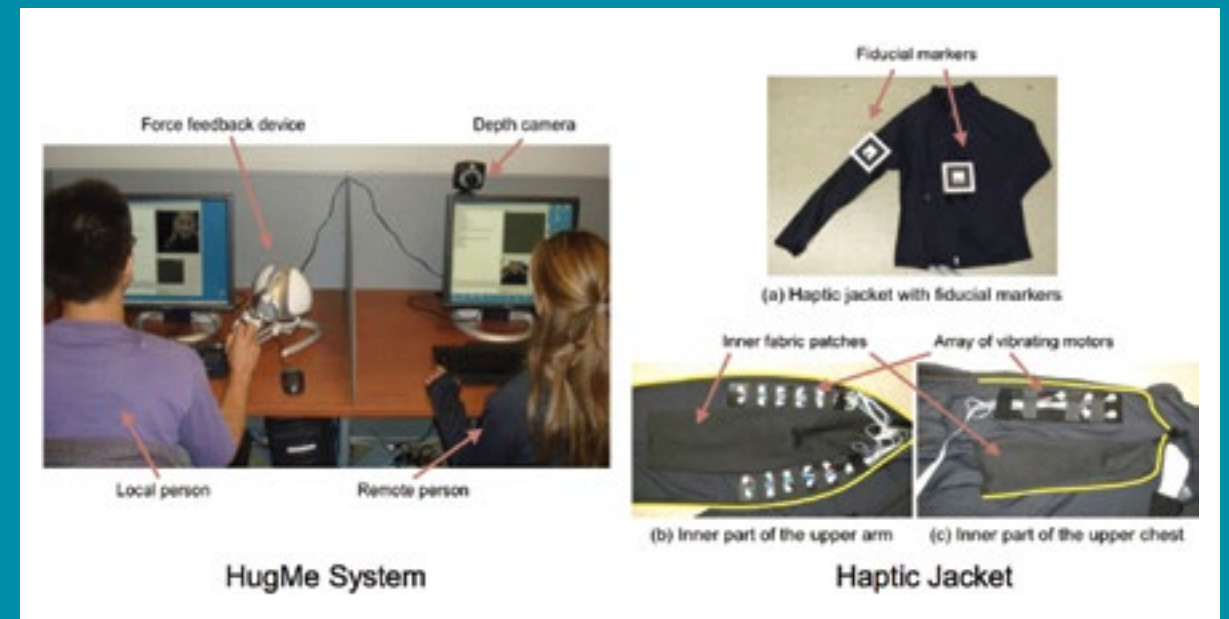
in three dimensions, to control a virtual slingshot. As you “pull back” your slingshot before “firing” the virtual payload, the commercially-available controller device gives you a realistic sensation of elasticity. And the “target” person — using a separate computer — must move, or he will feel the hit through the HugMe jacket. Shooters using the slingshot have been found to aim more precisely than those using a standard point-and-click interface.

The potential in the big business of computer games is obvious, but the possibilities go much further. Eid’s team has modified a commercially-made wheelchair so that it can be activated by the user’s blinks and eye motions, to help people with diseases such as Amyotrophic Lateral Sclerosis (ALS). These diseases can devastate motor skills, but eye-muscle control often endures. “We found commercial glasses with infra-red sensors to measure pupil movement,” Eid said, “and developed a novel graphical user interface paradigm, so that the wheelchair can be controlled by eye.”

In a first test, an ALS patient in the US mastered eye control of a modified motorized wheelchair in just 15 minutes.

The team is developing a related “virtual keyboard” to allow typing by eye-gaze and blinks. Add a computerized audio playback device, and patients will be able to “speak” even after control of vocal and finger muscles is lost.

Further possibilities come tumbling out of



ABOVE: The “HugMe” jacket in which the wearer can feel a remotely-applied touch, hug or even “gunshot” through vibro-tactile actuators inserted into the garment and controlled by a computer. **BELOW:** Mohamed Eid, assistant professor of Electrical Engineering, who is working on several projects in computer haptics.



Eid. One of local significance but global promise involves the learning of physical skills such as hand-writing: a haptic interface could allow a remote or computerized teacher to physically guide a child’s hand in forming Arabic letters; learning through muscle memory appears to be more effective for this purpose than visual learning. On this project, Eid said he is close to launching a

start-up commercial venture. And he is encouraging team members to work toward more start-up opportunities.

There is still a lot of practical work to be done in haptics. The HugMe jacket, for example, started with 32 actuators, but now Eid’s team is trying to optimize that number, balancing transmitted sensations with wearer comfort while keeping costs down.

Challenges abound. Hardware must minimize user fatigue — a growing issue as motion increases. Software must provide multi-modal synchronization; if a user’s haptic experience is not co-ordinated with visual and aural cues, the result is worse than a movie with out-of-sync audio.

Then there’s “multi-modal perception.” In our away-from-the-computer lives, each of our senses is more or less important in each second, depending on what we’re doing. Such switching among “dominant modalities” in the virtual world will not be easy.

These are early days for the study of haptics, but the manifold possibilities fuel Eid’s idealism. After all, he asks, “If we engineers are not helping people, then what are we good for?” ▾

DISPLAY OF CUTTING-EDGE RESEARCH

Gamma ray spiders from outer space. Android apps that survey farms. Collaborations between human and non-human animals. The first annual NYU Abu Dhabi Research Conference in February 2014 showcased the diversity of academic work that is happening at the University by bringing together more than 110 students and faculty from the Abu Dhabi and New York campuses. The three-day event featured talks, musical performances, and poster presentations.

NYUAD Provost Fabio Piano kicked off the conference by highlighting several of the University's successes from the past year. These included Rhodes and Falcon scholarships won by undergraduates, major grants awarded to faculty members, and accolades received from literary journals for an NYUAD Institute project.

Piano noted that as the school grows, so too does its academic output. In 2013, standing faculty published nearly 20 books and more than 140 journal articles, participated in nearly 80 conferences, and applied for several patents.

Students experienced similar success by publishing and co-authoring papers that have appeared in leading journals, while members of the inaugural class have been accepted to top Ph.D., medical, and law programs.

Many of the panels featured research that is interdisciplinary in its approach. For example, Adam Ramey, NYUAD assistant professor of Political Science, fuses techniques pioneered by psychologists and computer scientists with his interest in legislative institutions. His talk, "More than a Feeling: Social Media, Personality, and Voting in the US," argued that an analysis of American legislators' speeches and social media posts can provide insights about a legislator's personality, which is closely tied to their behavior in Congress.

The panel "Text, Image, Music," chaired by Judith G. Miller, dean of Arts and Humanities at NYUAD, brought together academics from literature, film studies, visual arts, writing, and music. Shamooun Zamir, associate dean of Arts and Humanities and associate professor of Literature and Visual Studies, discussed his current work on "The Family of Man," a photography exhibit that was curated by the famous photographer Edward Steichen. First shown at the Museum of Modern Art in New York, the exhibit toured the world and was seen by more than 9 million people.

On day one, David Holland, professor of Mathematics and Atmosphere-Ocean Science at NYU New York, chaired a panel that focused on the interaction between climate and sea-level change. Presenters included affiliates of the NYUAD Center for Global Sea-level Change (CSLC), and Holland concluded the session with a talk that focused on research that was recently published in the journal *Nature* that considers how warming in the North Atlantic is

tied to changes to the climate of far off Antarctica.

A panel on "Brain Science," chaired by Professor of Linguistics and Psychology Alec Marantz, highlighted the connection between the fields of biology and linguistics, while the "Genomics and Molecular Biology" panel, chaired by Associate Professor of Biology Kourosh Salehi-Ashtiani, featured an array of presentations from researchers who study algae, dates, human cells, and photoreactive chemical compounds.

"Future conferences will bring together even more students and faculty and will provide the local community with the opportunity to learn about the cutting-edge research that is happening here at NYUAD," said David McGlennon, vice provost of Research Administration and University Partnerships.



CORE TECHNOLOGY PLATFORMS

NYU Abu Dhabi has dedicated significant resources to developing one of the premier science and engineering research laboratories in the region. An integral component of the laboratories are the Core Technology Platforms (CTP), which are shared facilities that support research activities across disciplines. Each CTP consists of a suite of research-grade equipment and are defined by the type of research they facilitate. The CTPs will continue to evolve and develop as new technology is added and new areas of research are conducted at NYUAD.

CTPs are overseen by directors who oversee their development and management, and liaise with faculty and researchers about current and future research requirements. Support is provided by a team of highly qualified specialists, who maintain and upgrade the equipment, define standards for operational performance, and provide service across the CTPs.

Nuclear Magnetic Resonance (NMR) and Spectroscopy

The Nuclear Magnetic Resonance and Spectroscopy CTP hosts a variety of research-grade analytical instruments that perform qualitative and quantitative analysis of chemical compounds based on the interaction of electromagnetic radiation with matter.

Analytical and Materials Characterization

The Analytical and Materials Characterization CTP aids in the investigation of the characteristics, properties, structures, and performance of materials from the level of the millimeter, to the micrometer, to the angstrom.

Light Microscopy

The Light Microscopy CTP is equipped with devices that facilitate the viewing and imaging of both the surface and depth of live neurons and other living tissue. Equipment in this CTP can be used to obtain high-resolution images of fluorescent samples at specific depths and can produce scans of moving neurons at up to 428 frames per second.

Sequencing

Researchers in genomics and systems biology utilize the Sequencing CTP to investigate the arrangement of nucleotides in DNA. Equipment in this CTP facilitates human genome, RNA, and gene sequencing, and can be used to sequence a whole human genome in a day.

High-Throughput Screening

The High-Throughput Screening CTP is used by biologists and chemists to automate tests using biological and chemical materials. This technology is used in drug discovery, toxicity studies, and cell

biology research, and allows researchers to quickly automate the production of millions of chemical and biological tests.

Molecular Biology and Cell Culture Facility

The Molecular Biology and Cell Culture Facility aids in the cloning and sub-cloning of genes into different vectors; the creation of proteins that are used in biotechnology research; and the biophysical and biochemical structural characterization of different macromolecules.

Micro-Fabrication

The Micro-Fabrication CTP is used for systems in biosensing, energy conversion, and human health. Utilizing spin coating, mask and bond aligning, reactive ion etching, and vacuum evaporator techniques, this CTP helps researchers to produce micro- and nano-materials in a class 1,000 cleanroom environment.


Advanced Manufacturing and Electronics

The Advanced Manufacturing and Electronics CTP supports researchers with custom design and manufacturing of parts and equipment by utilizing both additive (3D printing) and reductive (CNC) techniques. The five-axis computed tomography (CT) system can scan objects of up to 24 inches for accurate reproduction.


Brain Imaging

Research in the Brain Imaging CTP utilizes magnetoencephalography (MEG) and functional magnetic resonance imaging (fMRI) to study the brain as it responds to a variety of stimuli. Currently, this CTP is being used to study the way natural language is processed by the brain.

STUDENT RESEARCH



NYU Abu Dhabi students are among the most talented in the world. They bring an astounding range of interests and skills to a richly diverse and exciting undergraduate experience. They are students who engage the process of learning with passion and rigor. They are students who strive to make their own mark on a more knowledgeable, productive, responsible, just, and peaceful globe. What follows is a small sampling of the excellent research students have conducted at NYUAD. A more comprehensive booklet that catalogs the capstone projects of the graduating class is available separately.



LIGHTWEIGHT CEMENT SYNTACTIC FORMS

The summer following Joseph Juma's (Class of 2014) junior year was a busy one. During his semester abroad at NYU Polytechnic School of Engineering in New York, he was engrossed with a project on lightweight cement that contains styrofoam balls and worked under the tutelage of Associate Professor of Mechanical Engineering Nikhil Gupta.

Juma's research was focused on the development of lightweight cement syntactic forms and polymer matrix composites for aerospace applications. He studied the compressive properties of hollow, particle-reinforced cement composites with different modes of testing. Traditional cements often contain a material called fly ash, but by using carefully engineered glass cenospheres — lightweight inert hollow spheres — Juma was able to produce lightweight cement that had significant strength and stress properties.

A substance's tendency to deform elastically when a force is applied to it, also known as modulus of elasticity, was determined in each sample of cement and then correlated to both the volume fraction and density values of each model. Correlating the volume fraction to the density of the samples helped to establish a relationship between the volume and the type of glass cenospheres used, to the weight and modulus of elasticity of each of the samples.

Within each density-specific test, different percentages of glass microballoons were incorporated, along with a control group that contained only cement. Juma found that within each of the three density specific studies, both the compressive strength and density decreased as the microballoon percentages increased.

Intrigued with the research work, Juma headed to Gupta's office to share his academic curiosities and research interest, and the discussion materialized into a full-time research project. By the end of the summer, Juma had modified the



Joseph Juma, Class of 2014

initial design of the experiments and tested mechanisms to ensure all the necessary tests were done before he came back for his senior year in Abu Dhabi.

As a civil engineering major, the opportunity to work in a mechanical

engineering lab was a rewarding experience. "The caliber of the Ph.D. students in the lab, the helpful professor, and my colleague — fellow senior Mohammed Omar — all helped made this summer research a success," Juma said. In addition to maneuvering the technicalities of research design and gaining first-hand experience using mechanical equipment, Juma said he also learned the importance of patience in a controlled environment.

Lightweight cement syntactic forms is a relatively new and promising field, which provides Juma with great opportunity for future research: "I knew that I could break new grounds if I invested my efforts in it. The concept of lightweight cement is becoming more and more common and might be used for rapid deployment of structures in developing nations. The rapid deployment of structures could aid internally displaced people who might need immediate semi-permanent sheltering."

Juma is currently working out the final details of his research with Gupta before publishing his research paper. ▀

USING ECONOMIC GAMES TO IMPROVE INSTRUCTION

Can a teacher's performance on an economic game help researchers to understand how she will perform in the classroom? Petrus Bosa Layarda (Class of 2015), who is majoring in economics, spent his summer working on a project that aims to answer this question. The project is sponsored by Ras Al Khaimah's Sheikh Saud Bin Saqr Al Qasimi Foundation for Policy Research, and is led by NYUAD Assistant Professor of Economics Chetan Dave.

The goal of the project is to find ways to improve English language instruction in the emirate of Ras Al Khaimah and in the region. While most studies of teacher performance consider credentials (such as degrees and certifications), years of experience, and other "objective" criteria, this project is different. "Professor Dave thought there might be some variables that aren't commonly used to judge teacher performance," Layarda said. "And that's where the economics comes in."

"We invited over 100 teachers to our lab in Ras Al Khaimah and asked them to work through a series of simulated economic games," he said. "The games measured teachers' sense of altruism, risk tolerance, and time preference," which, explained Layarda, are "proxy variables" for other behavioral traits that cannot be measured directly. Games like these have been used for research in economics, but have not been widely used in education research.

Teacher performance on these games was then compared to the results of their students' final exam grades. The results of the experiments are not yet published, but the duo already has plans to run more experiments using a similar methodology in the future.

Layarda chose to spend the summer in the UAE working with Dave and the Al Qasimi Foundation because of the internship's high level of responsibility. "I knew that I'd have the opportunity to be involved in the whole process. Not just doing data collection — but actually being involved in the experiments, preparing the experiments, and running the experiments."

Layarda spent eight weeks with the Foundation,



Petrus Bosa Layarda, Class of 2015

and when he wasn't working on experiments, he honed his research and writing skills. A typical non-experiment day would consist of reading literature relevant to the field and compiling annotated bibliographies. He also

contributed to formal literature reviews.

"Everything I did intensively for those eight weeks in Ras Al Khaimah will be extremely useful when I begin my senior Capstone project. I now have experience reading academic articles, I'm comfortable writing reviews of relevant literature, and I understand where researchers in the field disagree," Layarda said.

And his experience this past summer may lead to further work after he graduates from NYUAD. "Being involved in a real, onsite research project allowed me to put all the ideas that we learn about in the classroom into practice," Layarda explained. "Working with Professor Dave and the researchers at the Foundation encouraged me to consider a career in research."

Moreover, Layarda's experience wasn't just about academics. "Working in Ras Al Khaimah, I got to see what the UAE is like outside of Abu Dhabi and Dubai," he said. "Ras Al Khaimah is smaller than Abu Dhabi, which made it easier for me to interact with members of the community." ▀



Stills from the feature-length documentary *Máté Bede-Fazekas* is making about his father, a Hungarian opera singer.

AN ARTIST'S LIFE IN HUNGARY

Máté Bede-Fazekas (Class of 2014) is making a feature-length documentary that explores the life and career of his father, a famous Hungarian opera singer. The film is concerned with the way political shifts in a country can affect the personal lives and careers of its citizens.

Bede-Fazekas has developed his skills by working on a number of film projects during his time at NYU Abu Dhabi. In New York last year, he took the well-known Sight and Sound course that is offered at NYU's Tisch School of the Arts. In the course, he created an 18-minute film with a classmate called "The Invitation".

"The main character is tormented by guilt, and is obsessed with his girlfriend's death," Bede-Fazekas explained. "He decides there must be a way to bring her back, and he sets out to find a way." Bede-Fazekas has also worked on a movie shoot in the UAE's Liwa desert. And for his Capstone project,

under the guidance of his mentor Visiting Professor of Film and New Media Scandar Copti, and in collaboration with Nolan Funk (Class of 2014), he made an interactive movie that has eight possible endings: "There will be a decision moment when the audience as a group has to make a collective choice." He has also collaborated with NYUAD students and Professor of Music Carlos Guedes on an interactive film installation that has been shown in Dubai.

But the biggest and most personal project he has undertaken is the documentary about his father. In the summer of 2013, Bede-Fazekas traveled to his home country of Hungary to compile footage of his

father, who was born in 1933, and grew up during World War II and the subsequent communist era. Bede-Fazekas believes that his father's life story and career in the arts provides a fascinating example of how the war, and the subsequent communist regime, affected the lives of Hungarians.

Csaba Bede-Fazekas was discriminated against during the communist period, but now, 25 years after the fall of communism, he is being recognized for his many artistic achievements. "I want to document the process of his receiving these awards, how he reflects on the past, how he journeys through this whole thing, the decisions he made, and whether he regrets them or not," Bede-Fazekas said.

While in Hungary, Bede-Fazekas followed his father with a camera wherever he went. "We went back to his hometown, where he was born, in Sellye, down in the south of Hungary. The house is still standing and there were people that he knew from childhood there. To record these conversations between these people who haven't spent much time together since they were kids, was fascinating."

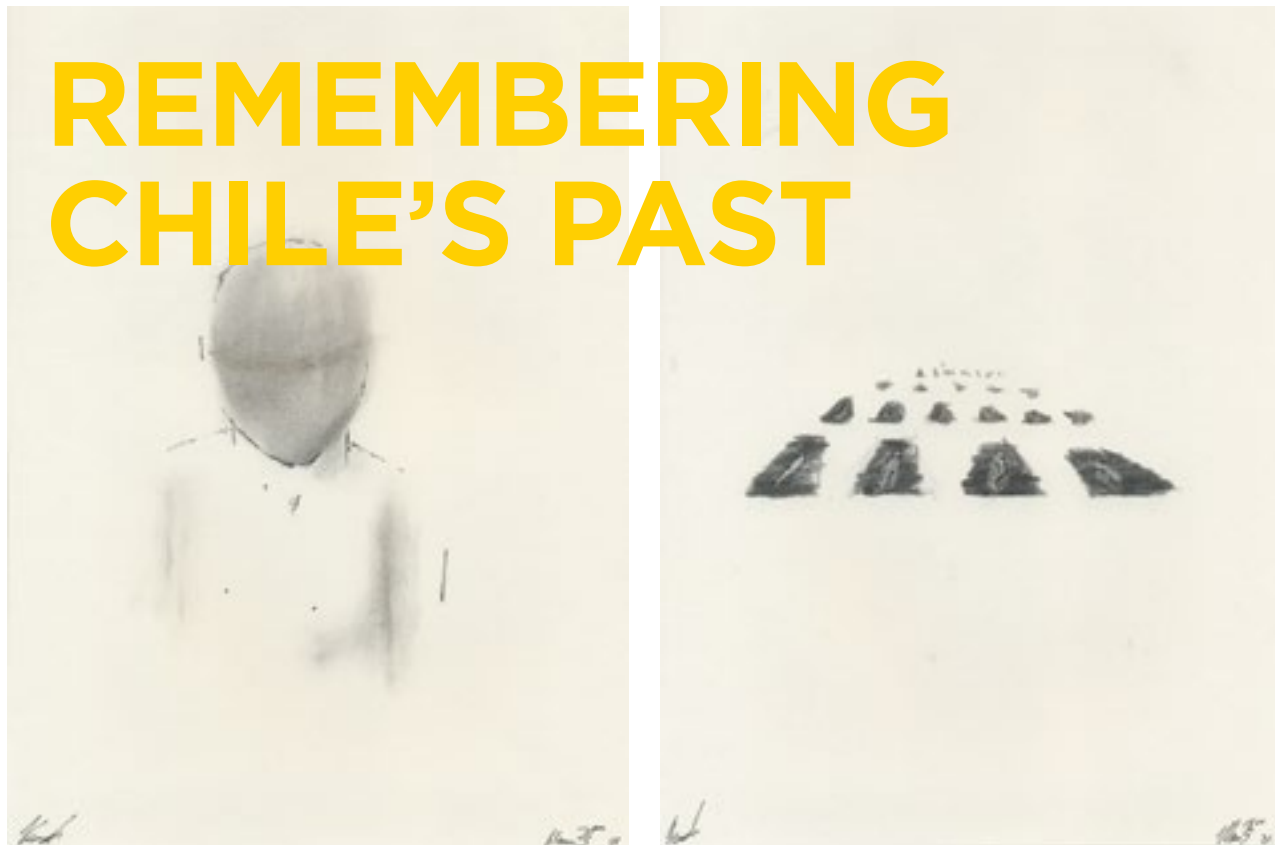
But it is not always easy to get his father to speak

naturally about his experiences. "My father's been an actor for 40 years, and in front of the camera he becomes someone else — a performer. That's something I'm trying to break down a bit; to get past it. I want him to be himself in front of the camera ...So, I try to have the camera all the time, to the point that he forgets about it."

Though the film focuses on his father's life in particular, Bede-Fazekas believes that the appeal of the story is more general, and "can tell about something that a lot of post-communist and post-socialist European countries still deal with, which is the dilemma of how when World War II was over, countries like Hungary became part of the Eastern block and changed, becoming socially oppressed. That process is probably still affecting people, as they never got a chance to speak about it."

What's next? Bede-Fazekas hopes to show the film on Hungarian television and plans to submit it to festivals. He is also considering pursuing a graduate degree in film, even if he doesn't do so immediately. "Part of me wants to start working first. I have some friends that I want to collaborate with, so I want to get in touch with them and see where that takes us," he said. ▀

REMEMBERING CHILE'S PAST



Although NYU Abu Dhabi junior Nikolai Kozak (Class of 2015) did not live through the dictatorship of Chile's Augusto Pinochet, the topic is not foreign to him — he grew up watching his father spend a big part of his life helping to free political prisoners in Chile.

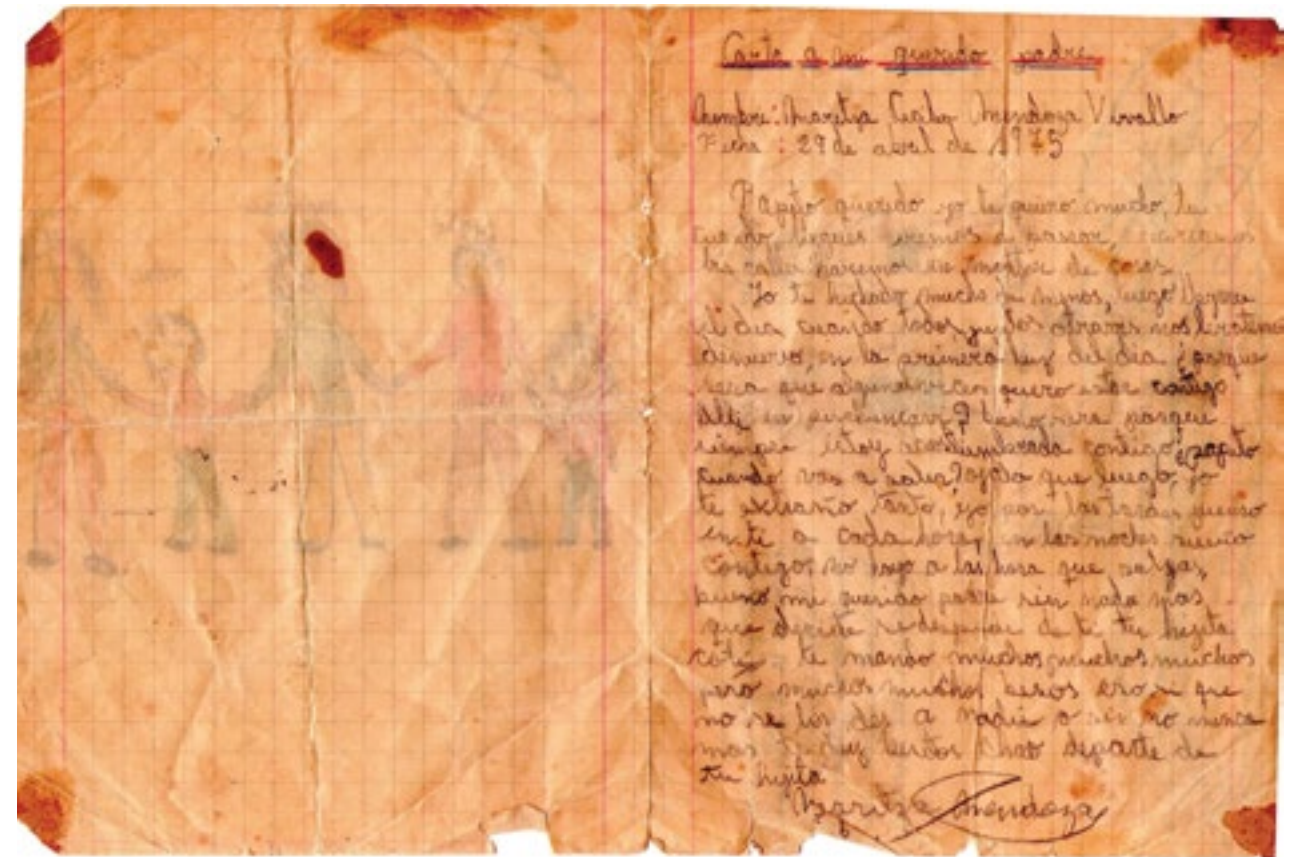
Pinochet took power in a coup d'état on September 11, 1973, and ruled Chile as president until 1990. While the sense of dictatorship is present in his life, Kozak, like most of Chile's youth today, never truly understood it. "Despite the pain, it's a subject that newer generations are quick to forget or dismiss," he said.

Kozak believes that each generation has its own collective subconscious, which affects how they think and deal with political and social issues. "The generation that was born and lived through the military regime had a very different understanding of what political, social, and economic life is, versus those that were born after 1990 — like me," Kozak explained. And Kozak is keen to initiate a conversation with young people regarding the

regime, its effects and relevance today: "Although I was not born during the political dictatorship, I do live under the political systems that were created by the people who had lived under the regime."

Bridging social sciences with arts, Kozak created an innovative way to address the difficult and complex topic. Titled *Memoria 35000*, Kozak's art project was named after the 35,000 cases of human rights abuses that happened during the dictatorship.

From the rich archives found in the Documentation Center at the National Museum for Memory and Human Rights, Kozak picked 60 letters, reports of abuses, manuscripts, and notices of detention and execution that he "felt illustrated very powerfully what was going on at the time," and created drawings based on these

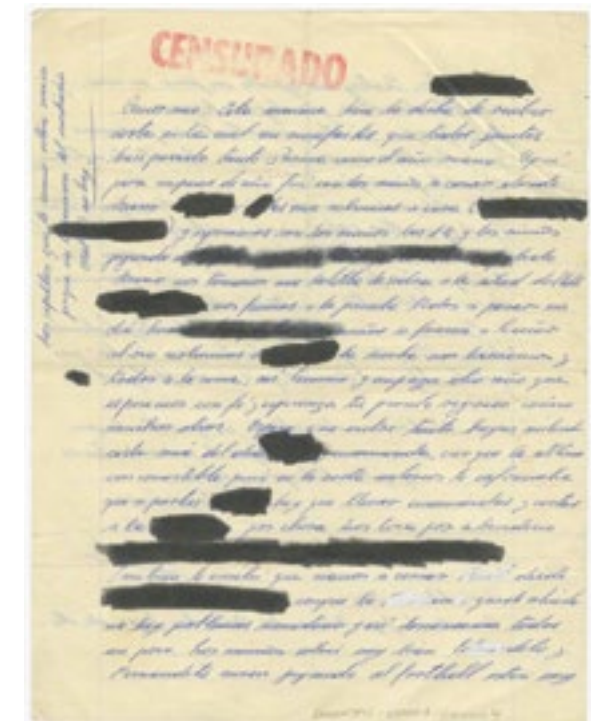


documents. He also took out portions from the letters and displayed these excerpts on their own. Unattributed without an author or date, these fragments also "served as a poetic interpretation" of the past, Kozak explained.

Not stopping there, during a visit to Santiago, Chile last summer, Kozak stenciled and wheat-pasted phrases from the exhibition and drawings into anonymous pieces of street art. The project was a deeply introspective experience for Kozak, and his hard work paid off when the Museum for Memory and Human Rights wanted to exhibit his work.

Having his project exhibited at the museum had huge significance for Kozak. "This museum is one of the most controversial and important national museums in Chile because of what it represents for the entire country. It plays a central part in the Chilean cultural paradigm, and being involved in it was an amazing experience," Kozak explained.

Memoria 35000 is slated to be exhibited at the museum in September 2014, coinciding with the 41st anniversary of the coup. ▀



TOP LEFT: Two of Nikolai Kozak's drawings, interpreted from old letters (this page) written from political prisoners to their families during the reign of Chilean dictator Augusto Pinochet. More drawings from *Memoria 35000* can be found at his website, www.nkozak.com.

USING CHEMISTRY TO CREATE SMART MATERIALS

NYU Abu Dhabi junior Selbi Nuryyeva (Class of 2015), from Turkmenistan, is a busy undergraduate with a packed schedule. For two years, she has spent summers and semesters as a research assistant intern in both Abu Dhabi and New York, and has published two papers and presented her work at international conferences. “Research is important because no matter how thick the textbooks are, there is still a huge chunk of science that remains unknown and undiscovered,” Nuryyeva said.



Under the supervision of NYUAD Assistant Professor of Chemistry Ali Trabolsi, Nuryyeva conducted her first research on the synthesis and characterization of molecular switches — molecules that can reversibly switch between two states, “off” and “on” under external stimuli based on the viologen moities.

Viologens are known to be electrochromic — they change color upon the application of a small electric current. The HV molecule Nuryyeva synthesized is transparent, and known as “off” state. But by reducing the molecule by one electron, it turns the molecule to an “on” state, changing the color to a dark purple. In this reduced form, the HV also absorbs ultraviolet light.

This led Nuryyeva and her colleagues to construct a device that sandwiched the HV between two glass slides. They then applied an electric current and

discovered that the HV was still able to exhibit a reversible color change within the device. “Such findings serve as a proof for the possibility of a smart window application where the color of the window can be controlled by a switch or a button. The application has the potential to limit the heat entering the buildings, reducing energy consumption from air conditioners,” Nuryyeva explained.

Nuryyeva also analyzed the dimerization and complex formation of HV with an organic macrocycle. Besides changing color, upon one electron reduction of HV, viologen on each branch becomes a radical cation — an ion, atom or a molecule that has an unpaired electron. Dimerization occurs when one radical attracts another, forming a dimer through strong interactions.

Besides dimerization, viologen groups are

also known to form a molecular complex with cucurbituril[7] (CB7), a water soluble organic macrocycle. The hydrophobic interaction between CB7 and the viologen group is a stronger preferred intermolecular force compared to dimerization. But experiments done by Nuryyeva’s team came up with a case where dimerization force is stronger than hydrophobic interactions.

A molecular switch like that could be used in nanomechanical systems, such as memory chips, and in drug delivery, where release of the drug is required as a response of an external stimulus. Such a drug would resemble the structure of the HV, and could be released upon electron reduction.

Her work on synthesis and characterization of molecular switches conducted in Abu Dhabi resulted in two papers. The research on the synthesis of HV and its characterization was the cover story in


the *Journal of Material Chemistry*, while the other paper on HV forming a complex with CB7 has recently been accepted by *Chemistry — A European Journal*. Nuryyeva also presented this work at the International Union of Pure and Applied Chemistry’s 44th World Chemistry Congress in Istanbul, at the American Chemical Society Northeast Regional Meeting in New Haven, Conn., and at NYUAD’s Annual Research Conference.

Nuryyeva sees that her passion for research in chemistry as a way of helping others, and plans to do new research with Trabolsi for her senior capstone project next year. “From the small scale of referencing other people’s papers, to the big scale of attending and exchanging ideas with other scientists in international conferences, research is a unifying bond between countries, eliminating all the borders,” she said. ▀



POSTDOCTORAL RESEARCH

Postdoctoral associates are a vital part of the research community at NYU Abu Dhabi. They contribute to research and scholarship by working on stand-alone projects or as members of the University's state-of-the-art laboratories. The following is a small sample of the work postdoctoral associates conduct at NYUAD.



GLACIER-FJORD-OCEAN COMPLEX

Over the past two decades, ice loss from Greenland's shrinking ice sheet has contributed one-quarter of the global rise in sea level.

Retreating outlet glaciers were responsible for about half the ice lost. But understanding the dynamics of the calving front — a glacier's terminus, where icebergs split off — remains limited and “poorly understood for several reasons,” said NYU Abu Dhabi Postdoctoral Associate and Visiting Assistant Professor Carl Gladish.

For one, access to the environment poses a challenge. For the past five summers, Gladish, who works with the Center for Global Sea-level Change, led by Professor of Mathematics David Holland, has collected observations at Jakobshavn Glacier, through which 8 percent of the Greenland Ice Sheet ultimately flows into the ocean. Jakobshavn terminates at the head of the long, narrow Ilulissat Icefjord. Icebergs as big as skyscrapers, unable to pass the shallow sill where fjord meets ocean, clutter the way. “But, more intrinsically,” Gladish continued, “the glacier-ocean interface is simply very complex,” involving different systems operating on disparate timescales by little-understood rules.

With temperature and salinity measurements from Ilulissat, Gladish, who received his Ph.D. in atmospheric and ocean science and mathematics, runs numerical models to better understand the interactions between glacier, fjord, and ocean. “It's a hypothetical world,” he explained. By varying conditions at the fjord boundaries, he can test different “what-if scenarios.” “Modeling cannot substitute for observations,” he said. “However, a numerical model allows us to work out the consequences of our hypotheses about what governs the physical behavior” of the environment.

The team is trying to discover how the retreat of



Carl Gladish conducting research in Greenland.

a glacier is being driven by melting at the interface of glacier and ocean, an interaction that should have a relatively small impact on a glacier as a whole. “It is kind of like trying to explain why a person can become ill after eating something small that upsets their system,” he said. “But there is strong evidence that temperature changes of one or two degrees Celsius are indeed responsible for quite large changes at major glaciers around Greenland.” ▾

GENETIC DIVERSITY OF THE DATE PALM

As a traditional staple of the Arab diet, dates have long had a central place in both the agricultural economics and the culinary repertoire of the UAE. Now Khaled Hazzouri, a postdoctoral associate at the Center for Genomics and Systems Biology at NYU Abu Dhabi, is working to discover the genetic origins of this iconic fruit.

Working in the 100 Dates! Project, led by NYU's Dorothy Schiff Professor of Genomics (and Dean for Science) Michael Purugganan, Hazzouri collects samples of different date varieties and performs whole genome deep sequencing, a process which provides detailed information about an organism's genetic make-up.

Other researchers have investigated the domestication of the date palm in particular regions, but 100 Dates! takes a broad view, working with samples obtained from North Africa, Pakistan, and points in between.

“People claim that the center of diversity for the date palm is Iraq. Others say Iran, Pakistan, or Egypt,” Hazzouri said. “There is some archaeological data to support these arguments, but in order to know for sure, we really need to do a full genome study with many samples.” Hazzouri thinks that today's date palm, like other crops from rice to apples, may have developed from multiple domestication events.

The team hopes to expand its sample from the original 100 varieties to 500 or even 1,000. “With the samples we already have, we've done deep sequencing, and we have information about a lot of the most important mutations that have happened in dates over the course of their domestication,” Hazzouri said.



Khaled Hazzouri

A wild ancestor of the date palm was likely cultivated by humans over several thousand years, developing in the process into the many varieties seen around the region today.

“Farmers of the past may have seen these wild plants and recognized

in them particular traits that they thought were valuable, and they would select the trees that had those traits for further cultivation,” Hazzouri explained.

The team hopes to make a “roadmap” of at least 400 date varieties that correlates the characteristics (color and sweetness, for example) of the different varieties with the genetic markers that code for those particular traits.

This work will help researchers know how genes affect different traits of the tree, such as fruit sweetness and yield and the ability of the trees to tolerate high salinity.

It may even help farmers in the region improve their yields by cultivating varieties that are well-suited to the environment. ▾

USING SYNTHETIC DYES TO UNDERSTAND BIOLOGICAL DEVELOPMENT

When most people hear “dye,” they likely think of colorful fabrics and Easter eggs. But for synthetic chemist and NYU Abu Dhabi Postdoctoral Associate Matthew O’Connor, dyes are a tool to study genetic development in organisms.

At NYUAD’s Dore Laboratory, a multidisciplinary research group studying complex biological systems, O’Connor creates synthetic dyes that bind to molecules called morpholinos. Morpholinos can inhibit gene expression in cells, a process researchers call “gene knockdown.”

Normally, molecules of ribonucleic acid (RNA) are responsible for protein synthesis in cells. These proteins are one of the ways in which genes are expressed in biological organisms. Morpholinos insert themselves into this process, blocking the RNA from directing the formation of proteins and thereby preventing the expression of certain genetic characteristics.

Morpholinos have enabled researchers to identify the role those proteins play in development. Normally, these molecules act immediately. But when bound to the dye molecules that O’Connor synthesizes, morpholino activity shuts off. These “caged” morpholinos can then be released when light is applied to the photosensitive dye molecules. The process enables researchers to observe the effects of gene knockdown at different stages of development.

In zebrafish, for example, if the gene for glutamate decarboxylase (GAD1) is suppressed early in the fish’s



Matthew O’Connor working in the Dore Laboratory.

development, the change will lead to fatal jaw and brain malformations. But by employing dye-caged morpholinos to knock down the GAD1 gene later in development, only non-lethal seizures are observed.

While his colleagues study the biological mechanisms behind these effects, O’Connor is developing a simpler, higher-yield process for synthesizing dye molecules. “From a synthetic standpoint,” he said, “there are certain craft challenges” left to address. ▀

STUDYING ALTERNATIVE APPROACHES TO TARGET CELL SIGNALING AND CANCER

Human cells are constantly developing, dividing, and dying. In a healthy individual, these processes are kept in balance; proto-oncogenes promote cell growth, while anti-oncogenes suppress it. Mutations in either type of gene can lead to cancerous cell growth.

NYU Abu Dhabi Postdoctoral Associate Louise Ashall, a cell biologist, has been working within a team from NYUAD’s Dore Laboratory to develop ways of inhibiting a group of oncogenes called Ras proteins, “the most commonly mutated oncogenes, accounting for 20 percent to 30 percent of all human cancers,” Ashall said.

Enzymes called CaaX proteases play an essential role in Ras maturation. So medicinal chemists at the Dore Lab synthesized molecules that inhibit one of the CaaX enzymes Ras proteins need to function. “These inhibitors are small molecules that interfere and block the function of the CaaX protease enzyme, thus stopping the protease from performing its role,” Ashall explained. “Our aim is to inhibit Ras indirectly through reducing the activity of the CaaX protease enzyme.”

Ashall has been testing the CaaX inhibitors in a live cell assay using a human colon cancer cell line. Using fluorescent “reporter” genes,



Louise Ashall

she can measure the effectiveness of CaaX inhibitors to disrupt Ras from the cell membrane and consequently stop pathways that promote cell growth.

Ashall is “interested in how cell signaling pathways are controlled and may become deregulated, which can lead to diseases” such as cancer.

Ashall hopes the team’s research into CaaX inhibitors will lead to advances in “gaining a better understanding of the mechanisms that are involved” in signaling cell growth. This “will allow scientists to manipulate signaling pathways to potentially design better drugs for control and treatment of diseases,” she said. ▀

EXPLORING THE MYSTERY OF ARABIAN GULF CORAL

Coral bleaching occurs due to a breakdown in coral-algae symbiosis, caused by stressful environmental conditions, such as extremes of light, temperature, or salinity. These environmental stressors result in the expulsion of algae that live in coral tissue, causing coral to appear bleached — they may even die due to starvation.

Bleaching can occur at one degree above the summer maximum temperature, approximately 30 to 31 degrees Celsius in regions such as the Great Barrier Reef and the Caribbean. In the Arabian Gulf, however, coral are exposed to summer temperatures up to 36 degrees Celsius — yet they somehow survive.

As ocean temperatures are predicted to increase one to three degrees in the next 100 years due to climate change, reefs elsewhere are expected to bleach every summer, which will lead to the death of many coral colonies. If this continues to happen every year, coral reefs may cease to exist.

Edward Smith, a postdoctoral associate at NYU Abu Dhabi's Marine Biology Laboratory, studies coral biology; his main goal is to discover what allows Gulf coral to survive under extreme conditions that would kill other coral. "Despite these thermally tolerant corals being unique in the global system, they haven't really been well-studied, and that's largely because of where they are based," Smith said. "The biggest selling point of the Gulf is that it is a natural aquarium in which to study climate change in corals."

Through extensive field work and laboratory experiments, Smith, along with Emily Howells, a postdoctoral researcher at NYUAD, conducts in-depth studies that address the molecular and the physiological aspects of corals in the Gulf. They are



Edward Smith, left, doing field research in the Gulf.

trying to learn if corals in the Gulf are genetically different from other populations, or if there are environmental conditions in the Gulf — such as light, sediments, or the salinity of the seawater — that allow Gulf coral to survive this extreme environment.

Furthermore, if Gulf coral are discovered to be genetically different, there are more questions to ask: What are the Gulf coral doing differently than others? How long has it taken Gulf coral to acquire these abilities to survive high temperatures? Smith explained: "What we can learn from the coral populations here will help us predict what is going to happen in the future with climate change, and it can also help guide future management of the reefs." His work may help keep tomorrow's coral reefs as colorful as they are today. ▾

DESIGNING COMPOUNDS TO TARGET CANCER

Shahienaz Hampton, a postdoctoral associate at the Dore Lab at NYU Abu Dhabi, is part of a team investigating Ras proteins, which function as molecular switches and are involved in transmitting signals within cells. When Ras is switched on, this subsequently turns on genes involved in cellular processes including cell growth and cell proliferation. Consequently, mutations in Ras genes, also known as oncogenes, result in the production of overactive Ras that may ultimately lead to cancer. As such, oncogenic Ras is implicated in and accounts for approximately 20 percent to 30 percent of human cancers, primarily pancreatic and colon cancers.

Ras possesses a four-amino acid sequence at one end of the protein, known as the "CaaX box". This undergoes a set of post-translational modifications, an alteration to the protein that is required to target Ras to the cell membrane.

The Ras converting enzyme (Rce1), a CaaX protease and an integral membrane protein, is one of the key modifying enzymes required in the maturation of Ras, causing it to be functionally active.

Hampton's current study targets this enzyme. "Our aim is to inhibit Rce1 so that Ras is unable to be correctly modified," she explained. "Subsequently, this may block the association of Ras to the cell membrane. As a medicinal chemist, I design and synthesize compounds with my colleague Idrees Mohammed, which hopefully will bind and perturb the enzyme's functionality."

The process starts with molecules that reduce the enzyme's activity, known as "hit compounds," which were identified as a result of a high-throughput chemical screen. Individual changes may then be made around the core of the



Shahienaz Hampton

compounds. This gives an insight into what modifications increase or decrease the activity of the enzyme, known as the structure-activity relationship (SAR).

"So far, we have managed to obtain moderate activity against this enzyme

with our small molecule inhibitors. We are very pleased about this," Hampton said. "We are hoping to increase potency of these compounds towards Rce1, and we would also like to improve selectivity against the functionally similar zinc metalloprotease, ZMPSTE24, also a proteolytic enzyme."

In the absence of the correct post-translational modifications, Ras is unable to localize to the cell membrane, thus resulting in mislocalised Ras and defective Ras signaling. Therefore inhibition of Ras maturation is considered to be a potential anticancer strategy. ▾

PROFILING OPTIC LOBE NEURONS IN THE FRUIT FLY

What makes one cell develop differently from another? Postdoctoral Associate Katarina Kapuralin is working to answer that question at NYU Abu Dhabi's Center for Genomics and Systems Biology. With Professor Claude Desplan's lab, Kapuralin is trying to learn how optic lobe neurons develop their specificity in the fruit fly brain.

The study of genomics has developed rapidly over the past decade. The genomes of several species – including humans – have been sequenced. This work has taught researchers about the similarities and differences among species and how they diverge. But there are many more questions to answer.

“We don't know much about particular cells and how they develop differently from each other,” Kapuralin explained. “So we want to learn more about the expression of the genes and transcription factors in a specific cell.”

Kapuralin's research progresses in several stages. She works with fruit flies (*Drosophila melanogaster*) that have been altered genetically. The first step is to make sure that the fly lines she works with have the modifications in one neuronal subtype only. This can be done by inserting green fluorescent protein (GFP) into specific genes. The GFP is expressed in the flies' optic lobe neurons, and allows researchers to identify this subset of neurons visually, under a microscope.

She then takes a random selection of flies from a particular strain and analyzes their neurons under a confocal microscope, to make sure that only one subtype of optic lobe neurons in the fly brain



Katarina Kapuralin

expresses the GFP.

Once she has identified a suitable line, she dissects many fly brains and further analyzes them on a FACS (fluorescence-activated cell sorting) machine that separates the optic lobe neurons that express GFP from other

cells in the fly brain.

The sorting allows her to get a very specific sample of optic lobe neurons; she then conducts RNA deep sequencing on these cells. “This detailed analysis will allow us to see the complete gene-expression profile of individual optic lobe neurons, and we will be able to correlate this transcriptome with their different defining characteristics,” Kapuralin said.

Once completed, this cutting-edge work may help the researchers understand how cell differentiation is carried out in the brain of fruit flies. And that knowledge could have wider implications for showing researchers how cells in organisms achieve their specificity. ▀

OBSERVING EPHEMERAL OBJECTS IN THE SKY

Astrophysicists look to the sky to study a variety of entities. There are familiar planets and stars, and the black holes and pulsars that are compelling due to their peculiar properties and behavior. But Aquib Moin is intrigued by transient objects that appear in the sky for seconds – and disappear.

“When you go out and look at the sky, you see stars, planets, and galaxies, which remain observable for a long time. But there are also short-lived events, and their origin is still a mystery,” said Moin, who is a postdoctoral associate in astrophysics at NYU Abu Dhabi working with Professor Ingyin Zaw. In particular, he is interested in gamma ray bursts (GRBs), which may be the result of catastrophic episodes, such as the birth or death of stars.

As their name suggests, GRBs are extremely powerful and bright bursts of high-frequency gamma rays. Most GRBs disappear in seconds. But others, as they grow older, emit radiation in lower-frequencies, like X-rays, visible light, and radio waves. (Gamma rays have wavelengths that are about as long as the nucleus of an atom, while radio waves can have wavelengths measured in centimeters to kilometers.)

Since the initial event is so short-lived, discovery and observation is a complicated process. NASA has satellites orbiting earth that scan the sky in search of GRBs. When a satellite observes a gamma burst, it sends a message to scientists on the ground who can direct terrestrial telescopes to the area of the sky where the burst was detected. This allows researchers like Moin to observe the lower frequency remnants of GRBs – the “afterglow” – and the interaction this radiation has with the space around it.

On April 18, 2010, NASA's Swift satellite detected a GRB that lasted for about 20 seconds, but was observable from Earth for two and a half years at



Aquib Moin

lower frequencies. Moin was granted telescope time by the Australia Telescope National Facility (ATNF) and US National Radio Astronomy Observatory (NRAO), which allowed him to observe the afterglow until it faded.


His findings were published in the December 20, 2013 issue of *The Astrophysical Journal*.

Using these telescopes, Moin collected data and ran it through theoretical models designed to help researchers reconstruct the origin of GRBs – the models can also help researchers understand why some GRBs last longer than others. “These tools help us trace the possible sequence of events back in time based on the emission profile to see what might have happened with the initial burst and afterwards,” Moin said. He believes that it is more likely that the GRB of April 18, 2010 was significant of an “exotic event like a star turning into a black hole.”

But Moin acknowledges that there is much more work to be done: “The point is that these objects still hold a lot of mystery, and I have another GRB that I just detected at radio wavelengths in February 2014 that I am studying right now. When I have a sample of three or four sources like that, then I will be able to make more concrete statements.” ▀



PUBLICATIONS AND PATENTS



From patent filings to books, journal articles to creative works, NYU Abu Dhabi researchers are increasingly leaving their marks on their respective fields. The following lists offer a selection of the research, scholarly, and creative output of NYU Abu Dhabi faculty and NYU Abu Dhabi Institute researchers for 2012 and 2013.



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Toussaint, G.T. (2013). On the question of meter in African rhythm: a quantitative mathematical assessment. In G. Hart & R. Sarhangi (Eds.). *Proceedings of Bridges: Mathematics, Music, Art, Architecture, and Culture* (pp.559-562), Enschede, The Netherlands, Phoenix: Tessellations Publishing, July 2013.

Tsoutsos, N.G. & Maniatakos, M. (2013). Investigating the application of one instruction set computing for encrypted data computation. *Lecture Notes in Computer Science* (including subseries *Lecture Notes in Artificial Intelligence* and *Lecture Notes in Bioinformatics*), 8204 LNCS, pp. 21-37, *3rd International Conference on Security, Privacy, and Applied Cryptography Engineering, SPACE 2013*, Kharagpur, India, October 2013.

Patent Filings

Al-Sharif, A.S., Jagannathan, R., Eid, M. and El Saddik, A. Smart Pen - Tracking movement of a writing instrument on a general surface, U.S. Patent pending, filed February 2013.

Bayram, S., Sencar, H.T. & Memon, N. Seam Carving Based Image and Video Anonymization, U.S. Patent pending, filed May 2013.

Davis, M. Continuous Feed 3D Manufacturing, U.S. Patent pending, filed December 2013.

El Saddik, A., Karime, A. & **Giakoumidis, N.** An Interactive Tangible Interface for Hand Motion, U.S. Patent pending, filed February 2013.

El Saddik, A. & Eid, M. H-Pen: A 2 DoF Force Feedback pen-shaped Device, U.S. Patent pending, filed February 2013.

Rajendran, J., Pino, Y., Karri, R. & **Sinanoglu, O.** System, Method and Computer-Accessible Medium for Facilitating an Unbreakable Logic Encryption, U.S. Patent pending, filed March 2013.

Rajendran, R., Pino, Y., Karri, R. & **Sinanoglu, O.** Systems, Processes and Computer-Accessible Medium for Providing Logic Encryption Utilizing Fault Analysis, U.S. Patent pending, filed January 2012.

Rajendran, J., **Sinanoglu, O.** & Karri, R. System, Method and Computer-Accessible Medium for Providing Secure Split Manufacturing, U.S. Patent pending, filed March 2013.

Rajendran, J., **Sinanoglu, O.** and Karri, R. System, Method And Computer-Accessible Medium For Fault Analysis Driven Selection Of Logic Gates To Be Camouflaged, U.S. Patent pending, filed September 2013.

Sinanoglu, O. Test Access System, Method and Computer Accessible Medium for Chips with Spare Identical Cores, U.S. Patent pending, filed June 2012.

Sinanoglu, O. System, Method and Computer-Accessible Medium for DfT Support for Launch and Capture Power Reduction in Launch-Off-Capture Testing, U.S. Patent pending, filed May 2012.

Sinanoglu, O. Systems, Processes and Computer-Accessible Medium for Providing a Bidirectional Scan Path for Peak Capture Power Reduction in Launch-Off-Shift Testing, U.S. Patent pending, filed January 2012.

Creative Works

Al-Ghoussein, T. (2013). Works exhibited in the following exhibitions: Venice Biennale 2013, Venice Italy, Photo Quay, 4th Photography Biennale 2013, Paris, France, The Blue Route 2013, The National Museum/Villa Empain 2013, Brussels, Belgium, Selected Works, Art Space 2013, London, UK (two man show), Voyage, Museum of Anthropology 2013, Vancouver, Canada, You and Me Beyond the Horizon, Nevada Museum of Art 2013, Nevada, USA, Mind and Body, DUCTAC 2013, Dubai, UAE.

Bravo, G. (2013). Was the producer and artistic director of “Music, Memory, Metamorphosis: Victor Ullmann’s 1944 Melodrama *The Lay of Love and Death of Cornet Christopher Rilke*,” L.A. Villa Aurora (April 2013).

Charlier, C. (2012-13). Music direction of the concerts “DUNES”, “IMPRESSIONS”, “TRADITION and INNOVATION”, and “MUSICAL IDENTITIES” at NYUAD.

Charlier, C. (2012). Wrote arrangements and recorded flute tracks for 3 songs of the album “Ay Amor”, by Mexican singer-songwriter Fabrizio Villegas. Album was launched in the USA and Mexico.

Charlier, C. (2012-13). Live performances at the Brazilian Endowment for the Arts, the Museu da Casa Brasileira, Sé Cathedral, São Paulo Cultural Center and Latin American Music Center in São Paulo, Brazil, Intercontinental Hotel and White Cube, Abu Dhabi.

Charlier, C. (2013). Flute and piano recital by Celina Charlier and Eshantha Peiris, at St Joseph’s Church, New York. Program: History of Tango by Astor Piazzolla (arrangement for flute and piano by Celina Charlier), Carmen Fantasy (Bizet/Borne), and a selection of music pieces composed especially for Celina Charlier by American composers Keith Thompson, and Ira Newborn, by Brazilian composer Edmundo Villani-Côrtes, and by Sri Lankan composer Hemapala Perera (world premiere).

Charlier, C. (2013). Recording of the CD “Dia de Lua” in Abu Dhabi, at Studio two454. Same repertoire as the one from the Evening of Song and Poetry event, all music and lyrics by Marcio Miele, arrangements shared by Marcio Miele (voice, guitar) and Celina Charlier (flute). CD released in the UAE, Brazil and USA.

Copti, S. (2013) Created and curated the Palestinian film festival at the Tel-Aviv Museum of Art in May 2013.

Guedes, C. (2013). Published his composition “C. mime for alto flute.” Amsterdam, Scherzo Editions.

Guedes, C. (2013). Published his composition “...neve de verão...” for vibraphone, Amsterdam, Scherzo Editions.

Hudson, D. (2012). Distributed Microtopias (new-media exhibition and curator’s essay), Finger Lakes Environmental Film Festival, Ithaca, New York 2012.

Katz, A. (2013). Screening of *Crossings* at HollyShorts Film Festival 2013, 22nd Woods Hole Film Festival 2013, 36th Asian American International Film Festival 2013, San Antonio Film Festival 2013, Palm Springs International ShortFest 2013, Newport Beach Film Festival 2013.

Magi, J. (2013). A sequence from LABOR. In K. Gonzalez & C. Pagel (Eds.), *jubilat* (24). Amherst, Massachusetts.

Magi, J. (2013). LABOR: Finding Guide Failure. In Y. Gluzman and S. Cleary (Eds.), *Emergency Index, Volume 2*. New York: Ugly Duckling Presse.

Magi, J. (2013). Four ways of the poetry-photography complex. In A. Zawacki (Ed.), *Poetry Northwest*. Everett, Washington.

Polendo, R. (2013). *Juárez: A Documentary Mythology*. A documentary theater work on the changes in Juárez, Mexico since the drug cartels took over, performed in Mexico, in Texas, and in New York. Devised and directed by Rubén Polendo with his company Theater Mitu.

Polendo, R. (2012). *Heartpiece*. An international performance project in collaboration with renowned Mongolian vocal artist Nominjin. The piece premiered in Ulaanbaatar before touring Mongolia. Conceived and directed by Rubén Polendo with his company Theater Mitu.

Quayle, M. (2013). Recorded and released the album *Amazed By You* (July 2013), a cabaret song cycle with original music and lyrics, featuring Marian Murphy (soprano) and Matthew Quayle (piano).

Roth, J.M. Had film premieres for two films she produced. New York Film Festival for North American Premiere of “Jimmy P.” directed by Arnaud Desplechin, and Tokyo premiere of “What Maisie Knew” directed by Scott McGehee & David Siegel.

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