INSIDE JERSEY MAGAZINE

How a Rutgers math professor is using numbers to fight the war on terror

Fred S. Roberts, a mathematics professor at Rutgers University who heads a 17-member consortium of universities and companies using sophisticated data analysis to help the U.S. Department of Homeland Security. (Amanda Brown | Inside Jersey Magazine)

 By Ted Sherman | NJ Advance Media for NJ.com

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Call him a code breaker.

Fred S. Roberts looks like a 72-year-old college professor, which is no surprise. He holds a doctorate in mathematics from Stanford, and his fourth-floor office at Rutgers University is a jumble of stacked papers and large whiteboards displaying complicated formulas scrawled out in red and green dry-erase markers. His desk, if it can be found under more paper, holds multiple computer monitors.

Ask him about his research interests and he'll talk about mathematical models, graph theory and combinatorics, measurement theory and operations research.

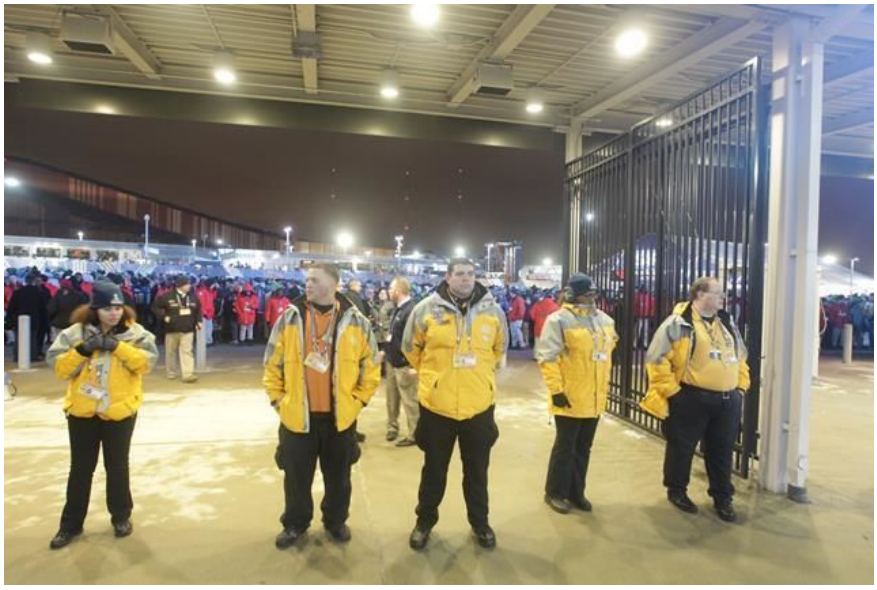
Most people have no idea what any of that means.

But Roberts is on the front lines of the nation's homeland security mission. Head of a 17-member consortium of universities and companies working with the U.S. Department of Homeland Security, he and his staff look to find order in numbers, conducting sophisticated analyses that has saved the U.S. Coast Guard millions, highlighted the growing threat of maritime cyber-attacks and advised the National Football League on how to better protect its stadiums.

"We're all data dependent," he says. "The problem is making sense of it."

The partnership led by Roberts at Rutgers is known as CCICADA (yes, the acronym deliberately misspells the word and has nothing to do with insects — it stands for Command, Control and Interoperability Center for Advanced Data Analysis). It uses data analysis and advanced mathematical modeling to connect dots, or figure out ways to find them. What's the best way to deploy radiation detectors in the heart of Manhattan to find a "dirty bomb"? (The answer might surprise you.) Where do you base Coast Guard vessels to cover the widest area at sea? Is there a way to defeat child sex trafficking by electronically sifting through millions of online ads?

"These are essentially large math problems," says Roberts, director of CCICADA, which has done work for U.S. Customs and Border Protection, the Transportation Security Administration, the Secret Service, the Port Authority and MetLife Stadium.



Security guards block an exit as crowds wait to board NJ Transit trains at MetLife Stadium after the Super Bowl between the Denver Broncos and Seattle Seahawks. (John O'Boyle | Star-Ledger file photo)

The academic research program was set up by the U.S. Department of Homeland Security, which has similar working agreements with more than 300 universities across the country. Matthew Clark, director of the Office of University Programs for the Department of Homeland Security's Science and Technology Directorate, says the program was launched with the realization that more and more data is being collected in connection with security demands, making it harder to figure out what it all means.

"Everything is digitized and you can sort through it somehow, but a lot of people are drowning in data," Clark says. "How do you make sense of a piece of information here and a piece of information there? It's like looking for a needle in a haystack, and the haystacks are getting bigger and bigger."

To make sense of it, researchers taking on homeland security assignments typically create complex algorithms, isolating hundreds of variables, coming up with a series of steps to solve a problem, or provide a glimpse at how small changes in those variables can affect an outcome.

State Police use specially trained dogs to check cars entering the parking lot at MetLife Stadium before the 2014 Super Bowl. (Robert Sciarrino | Star-Ledger file photo)

These are not esoteric, theoretical exercises by the universities. Clark points to an airport security program devised by two graduate engineering students at the University of Southern California that uses game theory to come up with a randomized checkpoint system. The students developed algorithms to determine how to best assign security units to cover airport access points or points of vulnerability, based on the number of security officers and K-9 units available on any given day. By building randomization and unpredictability into the system, they made it impossible to predict when and where a security team might show up.

"They doubled or tripled their interceptions," Clark says. "You never knew where the dogs or people would be. They intercepted drugs and machine guns. There was a tremendous uptick in the interception of those things."

He says the Coast Guard put the same software in place in Boston Harbor to set up patrol schedules, increasing the deterrence by the patrols while giving the agency more time to work on its boats.

[The Coast Guard's mounting budget woes]

Constrained by tight budgets and ships that often relies of the ingenuity of crews able to fabricate spare parts no longer made, the U.S. Coast Guard has one of the oldest fleets afloat, and at times struggles to live up to its long-held motto, Semper Paratus — Latin for “Always Ready.”

CCICADA's work for the Coast Guard focused on another problem — how to best deploy its fleet of smaller patrol boats where they are needed most. With more than 1,500 boats and cutters based across 400 stations, the analysis involved variables matching the capability and mission-hour requirements of each Coast Guard station to the boats they had available, providing a number of what-if scenarios for commanders. Take a boat from here and save money, but at what cost in mission trade-offs?

"They set up Coast Guard stations around the country back when people were in rowboats," Clark says. The software, he predicted, will save the Coast Guard $120 million over the next 20 years.

Vice Adm. Charles Michel, Coast Guard vice commandant for operations, says the software tools provided by CCICADA will also be used to help determine where aircraft are based, as well as validate air station locations. "The Coast Guard is

continuously looking for new and more efficient ways to utilize our air and surface assets," he says.

A U.S. Coast Guard response boat patrols the Potomac River in Washington, D.C. CCICADA worked with the Coast Guard to determine how to best deploy its fleet of smaller patrol boats where they are needed most. (Adam Eggers | U.S. Coast Guard)

CCICADA has conducted separate studies on how to deploy radiation detectors in Manhattan to find hidden radiological "dirty bombs" that some fear may one day get in the hands of terrorists. According to Roberts, many big city police departments have experimented with placing nuclear detectors in police cars. But a mathematical analysis conducted by CCICADA found there were not nearly enough police cars in New York City to provide much confidence in the probability of finding such a nuclear device.

Again, it was a math problem driven by statistical power. The larger the number of vehicles, the higher the potential of detection. However, Roberts says, researchers found Manhattan would need at least 4,000 vehicles equipped with nuclear-detection

sensors to reach a comfortable probability of detection. The city, though, only has about 3,000 patrol cars assigned to 76 precincts spread through the five boroughs, with just 500 to 750 of them in the streets of midtown and downtown Manhattan at any given time. Police cars in New York also typically remain in their precincts and do not drive around randomly, like an iRobot Roomba vacuum sweeping the floor for crumbs — leaving gaps of coverage and greater opportunity for the bad guys to avoid detection.

CCICADA's solution? Put the radiation detectors in taxis. There are more than 13,000 licensed cabs in New York and most are constantly — and randomly — on the move, seemingly never leaving Manhattan.

Intercepting lone wolf attacks

In a program launched by Rutgers University, law enforcement agencies are being encouraged to work more closely with local communities to be alert to signs of potential terror attacks.

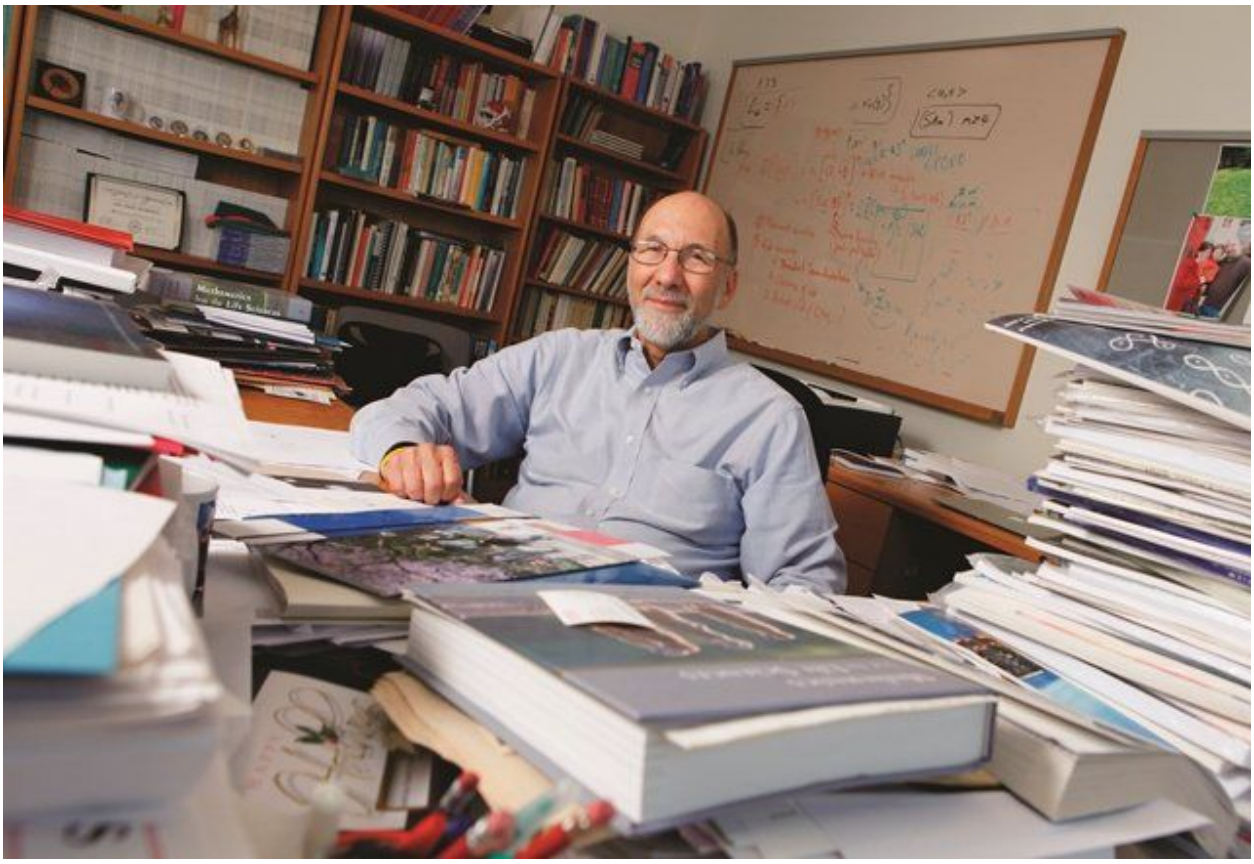
Rutgers' academic partners in CCICADA are Carnegie Mellon University, City College of New York, Howard University, Morgan State University, Princeton University, Rensselaer Polytechnic Institute, Texas Southern University, Tuskegee University, University of Massachusetts-Lowell, University of Southern California and University of Illinois at Urbana-Champaign.

A team at USC has headed a research effort by CCICADA to target child sex trafficking. Funded in part by the FBI, the Los Angeles Police Department, the New Jersey Office of the Attorney General and the U.S. Department of Justice, the group came up with algorithms to sort through millions of public online ads, looking for coded language, phone numbers, geographic locations and other markers for the sex trafficking of kids.

The partnership has also done work for sports stadiums across the region — research that has taken on a growing significance in the wake of the coordinated terrorist attacks in Paris in November.

"We have not been tasked with any specific initiative arising out of the ISIS threats or homegrown terrorism. However, clearly, the stadium event in Paris, and even the concert hall event, are closely related to things we work on and we have been discussing lessons learned and next steps with venue partners," Roberts says.

In 2014, faculty and student researchers from Rutgers, armed with calculators, clipboards and hand counters, collected field data during a soccer match between Ireland and Portugal at MetLife Stadium in East Rutherford, gathering information on the use of walk-through metal detectors to screen patrons at one of the stadium's entryways. Roberts says the group came up with an inspection program that helped determine how many inspection lanes to open; how many inspection tools, such as walk-through metal detectors, to buy; and how many inspectors are needed.



Fred S. Roberts of Rutgers, director of Department of Homeland Security Center of Excellence for Command, Control and Interoperability Center for Advanced Data Analysis. (Amanda Brown | Inside Jersey)

At Yankee Stadium, CCICADA evaluated aspects of stadium security from inspecting bags to credentialing employees. Roberts says the work on stadium security has been applied to five NFL stadiums: MetLife; M&T Bank Stadium in Baltimore; FedEx Field in Landover, Md.; AT&T Stadium in Arlington, Texas; and Lincoln Financial Field in Philadelphia.

Roberts adds that, for quite some time, there has been continuing work by various university centers dealing with homeland security, looking at ways of combating domestic violent extremism. "This theme will certainly cut across some of the work that we will do in the future. But it is a bit early to know precisely how," he says.

Clark says the university-based initiatives continue to grow nationwide, yielding very real results.

"You know you're going to strike out. But you look for the singles, doubles and triples," he says. "And we're hitting it out of the park sometimes."

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