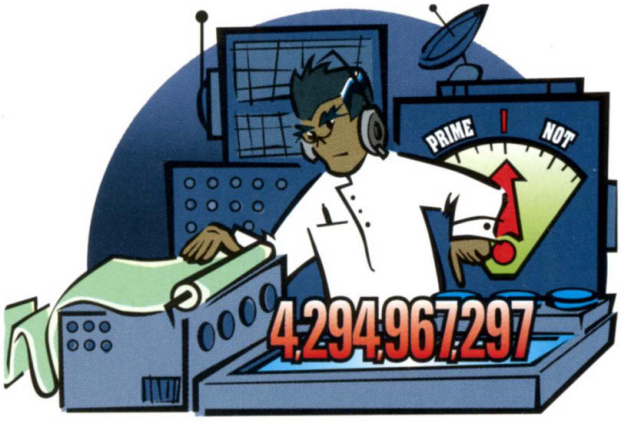
(whole numbers evenly divisible only by themselves and 1). Manindra Agrawal, a professor of computer science, and two students, Neeraj Kayal and Nitin Saxena, announced their result early this month, e-mailing copies of it to a number of experts in computational number theory.

"This is really fantastic, that we now know this to be true," says Hendrik Lenstra, one such expert at the University of California, Berkeley. The new result tidies up one of the corners of modern cryptography, which relies on hard-to-factor composite (nonprime) numbers to encrypt information. Although the algorithm is not practical at present, just knowing that it exists "simplifies our picture of what is going on," notes Andrew Odlyzko, a computational number theorist and director of the Digital Technology Center at the University of Minnesota, Twin Cities.



Prime suspect. A surprising new algorithm serves as a quick lie detector for positive integers.

What especially intrigues number theorists is that the algorithm and the proof of its efficiency are both very simple. Lenstra says he printed out the paper and discussed it with colleagues over dinner. "Before we had coffee we knew it was right," he says.

Put technically, the new result is a "polynomial time" algorithm for primality testing. That means it can take any N-digit number and return a yes-or-no answer in a run time bounded by a power of N—in this case, N^{12}. In computer science, polynomial time is the gold standard of efficiency. Any algorithm whose run time increases more steeply than that (as, say, 2^N does) quickly becomes time-consuming enough to bog down even the fastest computer.

Like other modern tests for primes, the new algorithm is based on a number-theoretic fact that Pierre de Fermat (of Last Theorem fame) discovered in the 17th century: If n is prime, then it evenly divides $a^n - a$ for any number a. Fermat's test makes it possible to prove that a number n is not prime without finding any of its factors. For example, $2^9 - 2 = 510$, which is not divisible evenly by 9. Hence, 9 cannot be a prime number.

Unfortunately, some composite numbers n also evenly divide $a^n - a$. To eliminate such "false positive" readings, the new algorithm runs a more elaborate but still elementary test, based on searching for pairs of numbers that fulfill a few simple conditions. If the search is successful, then n is declared composite; otherwise, it's prime. The key to the algorithm's efficiency is that the search can be restricted to a small range of numbers.

Constructing the primality test took a year of grueling work, Agrawal says. "There was nothing like an 'in a flash everything started making sense' feeling," he says. He and his students whittled away at the problem from various angles until July, when Agrawal hit on a substitution that made the last roadblock melt away.

"It's a bit of a surprise that such an easy algorithm had been missed all these years," says Carl Pomerance, a number theorist at Bell Labs in Murray Hill, New Jersey. "It's a delightful surprise—and perhaps also a bit of an embarrassment for those who have been working in the field, such as myself."

Cryptographers might well have more mixed feelings. They rely on now-difficult number theoretic computations, such as factoring large numbers, to safeguard cryptosystems that have become mainstays of the computer security business. If primality can be vanquished so easily, who's to say that a polynomial-time algorithm for factoring isn't just around the corner? Or, as Pomerance puts it, "What else have we overlooked?"

–BARRY CIPRA

ITALIAN REFORMS

Planned Mergers Raise Hue and Cry

NAPLES—Earlier this month Italian scientists were stunned to learn that their government is planning a major overhaul of the country's scientific establishment, including the axing of several institutes. Researchers are denouncing the plan, leaked to a prominent newspaper and denied by the government, as a ham-handed power grab drafted without their input.

According to a report in the 2 August edition of *la Repubblica*, the Ministry of University and Scientific Research intends to abolish eight publicly funded institutes and transfer the staff to the country's National Research Council (CNR). The institutes include the Anton Dohrn marine biology research station (Stazione Zoologica) in Naples, the National Institute of Applied Optics in Florence, and the National Institute for Experimental Oceanography and Geophysics in Trieste. Internal reforms would also be implemented at CNR, the Italian space agency, the National Institute of Geophysics and Volcanology, and the National Institute for Astrophysics.

"The Stazione Zoologica is a center of excellence," says Antonio Miralto, the institute's former director. "To have researchers of the Stazione Zoologica become part of the CNR would be a great error on the part of the government." William Speck, director of the Marine Biology Laboratory in Woods Hole, Massachusetts, says he was "shocked" by the news. "It is the oldest marine laboratory in the world."

CNR researchers are especially upset about a provision to choose institute directors through a top-down selection process, overseen by a president and an administrative council dominated by government appointees. Franco Pacini, an astronomer at the University of Florence and president of the International Astronomical Union, blasts this proposal as "obscene and unacceptable. It will basically put in the hands of politicians or administrators the choice for the best scientific leaders, even at the intermediate level."

The government's draft plan is close to its final form, says Claudia Di Giorgio, the journalist who received a leaked copy of the so-called "decree" after promising not to distribute it. However, a ministry spokesperson told *Science* that research minister Letizia Moratti is still working on the decree, which will be distributed to political bodies and the scientific community at the end of next month.

CNR is already moving to consolidate its 300 institutes into 100 larger units, and several scientists say it's ironic that the decree comes just as CNR has moved toward a more open selection process for its scientific directors. In addition, they are extremely unhappy that the proposed changes

Sinking feeling. The world's oldest marine biology research station at Naples is one of eight institutes slated for extinction.

CREDITS: (TOP TO BOTTOM) ILLUSTRATION: TIM SMITH; HISTORICAL ARCHIVES, STAZIONE ZOOLOGICA ANTON DOHRN

were drafted without their input. "I was not consulted by the minister … we didn't receive any formal information," says Lucio Bianco, CNR's president, adding that he first learned about the decree's contents in the newspaper. "If the description of the document is true, it cannot be acceptable to the researchers of the CNR."

Bianco says that he hopes to discuss the reforms with Moratti "in an open way" after the government returns from vacation in September. In the meantime, scientists are planning to stage a public protest and will discuss the government's proposal at a meeting on 10 September in Rome organized by Italy's Association of Ph.D.s and other groups. Few scientists contacted by *Science* believe that the reform measures will survive in their current version.

–ALEXANDER HELLEMANS

Alexander Hellemans is a science writer in Naples.

ANIMAL BEHAVIOR

Birds Spy on Neighbors To Choose Nest Sites

Information is power, even for birds. Faced with tough choices, animals that know how others have fared in comparable situations can make better decisions. On page 1168, researchers report that collared flycatchers decide where to nest and whether to return the next year based in part on knowledge of their neighbors' reproductive success. "How individuals collect this information is enigmatic," says Tomas Pärt, an evolutionary ecologist at the Swedish University of Agricultural Sciences at Uppsala. "This result suggests that the cues used may be unexpectedly fine."

Choosing a good breeding site may mean the difference between begetting many offspring or none at all. Previous work on group-nesting seabirds, such as cormorants and kittiwakes, had turned up observational evidence that birds monitor the success of their fellows in assessing breeding sites. A team led by Blandine Doligez, then at France's National Center for Scientific Research (CNRS) in Paris and Uppsala University, tested experimentally to what extent birds make use of information gleaned by watching their neighbors, which ecologists call "public information."

Doligez, now at the University of Bern, Switzerland, worked at a long-term research site at Gotland, Sweden, where collared flycatchers sport identifying color-coded leg bands. Researchers there had noticed flycatchers peering into the nest boxes of other birds. "No one really focused on this behavior, [but] I thought, that's really a sign" they're gathering information, she says.

To manipulate such information, the researchers took nestlings from some nests and added them to others, creating some plots of woodland with supersized broods and others with measly numbers of young. The team then monitored these plots and two types of control areas for 3 years.

The manipulation had a marked effect. Outsiders preferentially moved to plots augmented with nestlings, apparently judging these plots to be productive. But having extra mouths to feed forced parents to spread food more thinly, so youngsters on these plots were smaller. Emigrants picked up on both cues—and viewed the cup as half-empty rather than half-full. They fled both treatment plots at equally high rates, responding negatively to lowered quantity or quality of young. Emigrating birds "know what's going on in their own area," Doligez explains. Immigrants, however, are at a disadvantage and may be unable to pick up on relatively subtle clues, she says.

Nosy. Collared flycatchers peer into neighbors' nests when prospecting for breeding sites.

The birds also appear to be using information from their own breeding experience when making dispersal decisions. Parents of experimentally reduced nests were more likely to fly the coop than birds with unmanipulated nests, whereas the nestling recipients were more likely to stay put.

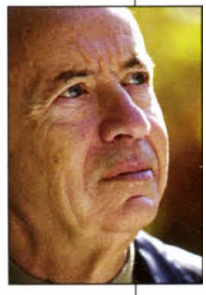
Such findings highlight the importance of animal behavior to population biology, notes conservation biologist J. Michael Reed of Tufts University in Medford, Massachusetts. "Dispersal is often treated as diffusion in population models even though for many species it is a result of a series of behavioral

CREDITS: (TOP TO BOTTOM) PAUL SAKUMA/AP; B. DOLIGEZ; ROGER WILMSHURST/FRANK LANE PICTURE AGENCY/CORBIS

ScienceScope

Stem Cells by Intel The University of California, San Francisco (UCSF), last week announced a $5 million gift toward a $20 million fund that will allow its researchers to expand their work on embryonic stem cells.

Intel chair Andrew Grove (below) said that he would match every gift between $50,000 and $500,000, up to $5 million, to help the university set up the Stem Cell Discovery Fund and a research program to cultivate and study newly derived cell lines. UCSF is one of two U.S. universities to produce human embryonic stem cell lines listed in NIH's Stem Cell Registry, but the new fund will let its researchers go beyond those derived before President George W. Bush's deadline of 9 August 2001.



New Path for Ph.D.s A National Research Council (NRC) report has proposed a fellowship program for newly minted Ph.D.s who want to work with kids. The program would provide schools with expertise that's hard to come by and young scientists with an alternative career path.

The 2-year, $35,000-a-year fellowships would train scientists to use their skills in the classroom, at science museums, or in other education settings. "They probably won't be teaching fourth-grade math, but they could be a tremendous resource specialist for an elementary school," says panel member Margaret Cozzens, vice chancellor at the University of Colorado, Denver. "We think there'll be a big demand," says panel chair Patricia Morse, a marine biologist at the University of Washington, Seattle.

The report, *Attracting Science Ph.D.s to K–12 Education*, estimates it would cost $2.5 million a year to support 30 fellows.

Big Green Donation An international fund to protect the global environment won a $700 million boost last week after the United States agreed to increase its contribution. The agreement comes days before the World Summit on Sustainable Development in Johannesburg, South Africa.

After months of negotiations (*Science*, 31 May, p. 1596), the donor countries of the Global Environment Facility approved a $2.92 billion budget for the next 4 years. CEO Mohammed T. El-Ashry says the money will support continuing efforts to protect biodiversity and mitigate climate change as well as new work on combating persistent organic pollutants and desertification. Some $70 million of the $500 million U.S. contribution will be tied to the fund's performance.