# Mathematics

## Spying pi in the sky

It's calculated in the stars.

In the April 20 NATURE, Robert A.J. Matthews of the applied mathematics and computer science department at the University of Aston in Birmingham, England, describes how to use the distribution of bright stars across the night sky to deduce a surprisingly accurate value of pi ($\pi$), the ratio of the circumference of a circle to its diameter.

"My aim was to extract something mathematically interesting from something we're all familiar with," Matthews says.

This result follows from an application of certain theorems in number theory. These hold that, given any pair of whole numbers chosen from a large, random collection of numbers, the probability that the two numbers have no common factor other than 1 is $6/\pi^2$ (about 0.61). For example, in a set of numbers including 8, 9, and 27, 9 and 27 have the common factor 3, whereas 8 and 27, as well as 8 and 9, have no common factor apart from 1. It's possible to calculate the value of pi by determining what proportion of pairs of whole numbers selected from a large, random sample has no common factors.

As the source of random numbers for his "celestial" estimate of pi, Matthews used the angular separation between the positions of pairs of the 100 brightest stars. He checked a million pairs of these numbers for factors and obtained a value of 3.12772 for pi, which is within 0.5 percent of the actual value of 3.14159.... "The ancient Greeks used to believe that numbers lie at the root of all things," Matthews notes. "I guess this result tends to support that idea."

## Next number, please

What's the next whole number in this sequence: 2, 4, 7, 11, 16, 22, 29?

The answer can be found in one of more than 5,000 entries in the *Encyclopedia of Integer Sequences* (Academic Press, 1995), a unique mathematical catalog compiled by Neil J.A. Sloane of AT&T Bell Laboratories in Murray Hill, N.J., and Simon Plouffe of the University of Quebec in Montreal.

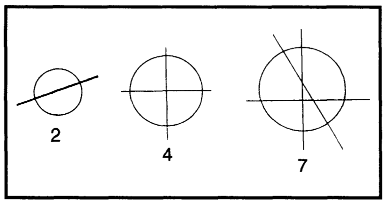
Starting with "the zero sequence," which consists of an infinite string of zeros, each entry in this catalog gives the first dozen or more numbers of a particular sequence, the sequence's name, a mathematical description or formula showing how to obtain successive terms, and citations indicating where the sequence has come up in the mathematical or scientific literature.

Sloane has been collecting integer sequences since 1965, when he was a graduate student at Cornell University. Within a decade, he had enough material to publish an annotated list of 2,372 sequences in *A Handbook of Integer Sequences* (Academic Press, 1973). This volume became a standard reference for mathematicians and many others interested in numbers in a wide variety of contexts, from studies of knots to research on RNA sequences.

Sloane also has an on-line version of his new sequence encyclopedia. By sending a message such as "lookup 5 14 42 132" to the electronic mail address *sequences@research.att.com,* a user can find out whether this or any other sequence is in the table.

Since completing the encyclopedia, Sloane has added more than 500 new sequences to his collection. About 250 of these entries have come from R.G. Kunstleve, a crystallographer in Zurich who has been enumerating sequences that arise in studying the number of atoms in various solids.

Sloane




*Counting the pieces when slicing a pancake: 2, 4, 7, 11, 16, 22, 29, 37,....*

# Technology

## Computer double-checks mammograms

Even a trained radiologist can miss a potential malignancy when reading a mammogram, the specialized diagnostic X ray aimed at locating incipient breast tumors. In fact, physicians can fail to spot between 10 and 30 percent of cancers present in women who get breast X rays.

With the help of a new computer system, though, physicians may cut the number of missed cancer diagnoses in half.

Kunio Doi, a radiology researcher at the University of Chicago, and his colleagues report putting the first computer-assisted program for analyzing mammograms into clinical use. Doi likens the system to a spell-checking program, used in word processing to catch typographical errors before printing a document. The computer mammography program offers a second opinion, pointing out areas that should be double-checked before signing off on a patient's good health.

In retrospect, physicians find that as many as two-thirds of all false negative mammograms show subtle evidence of cancer that interpreters overlooked, Doi's team reports.

In roughly half of all early breast cancers, tiny deposits of calcium resembling a "constellation of faint stars" appear on the mammogram. Often, other features on the X ray obscure those starlike deposits. Doi's group has trained the computer to spot the calcified constellations, even when covered by "clouds" of normal tissue, they explain.

By comparing the symmetry of the right and left breasts, the system can detect subtle masses, which account for another 40 percent of early cancers.

Three studies give the computer detection system a good grade, the scientists state. The first found the computer catching 85 to 90 percent of early cancers in 200 mammograms. The second showed the system spotting half the tumors missed by trained radiologists. The third noted that a radiologist using the computer found 92 percent of the cancers, compared to 85 percent for a radiologist working alone.

The computer and physician, each with distinct strengths and weaknesses, complement each other, says Robert Schmidt, a Chicago radiologist. Physicians make the best final judgments, but the computer doesn't get distracted by interruptions or feel tired and cranky.

The computer isn't perfect, Schmidt adds, but it can substantially improve diagnostic accuracy.

The researchers estimate that the system will cost about $100,000, making it affordable to most radiology groups.

As many as one U.S. woman in eight will have breast cancer during her lifetime, according to the American Cancer Society. In 1995, that will amount to roughly 207,000 new cases.

## Tracking potholes

An automated system to inspect pavement may help keep the nation's roads and sidewalks in better shape.

Video cameras mounted on a trailer record images of the road on tape as the vehicle speeds along at 30 to 50 miles per hour, report Sidney Guralnick and Eric Suen, engineers at the Illinois Institute of Technology in Chicago. With their colleagues, they are road testing the electronic monitor, contending that it will cut the time and cost of street maintenance. In most cities, inspectors on foot eyeball pavement stretches, then make notes about the condition.

The automated system highlights the contrast between light and shadows on the road surface as it records moving pictures. A computer then analyzes the images, helping engineers to follow road deterioration and plan repair strategies, the engineers say.

If all goes well after a year of trials, the system may move into manufacturing, yielding units that could cost as little as $60,000 apiece, says Guralnick.