Computers

Prime time for idle computers

In the few hundredths of a second between a user's keystrokes, a computer shared by several users has a lot of time on its chips, enough time to zip to another program, perform a couple of calculations and scurry back without the user being any wiser. Paul A. Pritchard, a computer scientist at Cornell University, is exploiting a computer's idle time by running a "background" program that seeks long arithmetic progressions of prime numbers. These progressions are made up of numbers that are divisible only by 1 and themselves and that have the same difference between successive numbers. So far, Pritchard has discovered one sequence of 18 prime numbers in an arithmetic progression, breaking the record of 17.

Pritchard's sequence starts with the prime number 107,928,278,317. Adding 9,922,782,870 repeatedly produces 17 more prime numbers. The nineteenth number is not a prime, so the arithmetic progression ends with the eighteenth number: 276,615,587,107. A VAX-11/780 computer whiled away 250 hours of scrounged time to find this record-breaking sequence. With two computers, Pritchard has now completed 20 percent of his search, using almost 3,000 hours of computer time. "I was very surprised how much time was available on what seemed to be heavily used machines," Pritchard says.

Pritchard's spare-time project arose out of earlier work in developing a new method for listing all the prime numbers in order. His current program incorporates several ideas for making the search faster. "My method is probably an order of magnitude faster than the previous method that got the record of 17," says Pritchard. However, there's still "an awful lot of searching."

After his program finishes, Pritchard plans to compare the results of his quest with theoretical predictions of how many of these arithmetic progressions he should have found. "If there were something very unusual that happened, say I expected to find 10 18s, and I didn't find any," Pritchard says, "then that would be very interesting to pure mathematics and would merit a lot of investigation." He adds, "But no one expects that to happen."

A computer's dusty 'head crash'

If a Boeing 747 flying low over a plain suddenly confronts a mountain, a crash is inevitable. A "read-write" or recording head, which transfers bits of data to and from magnetic disks that make up a computer's memory, can also "crash," but the culprit is usually a dust particle. Such a recording head normally skims on an air cushion just 20 millionths of an inch thick over a rapidly spinning disk surface. The head, a ¼-inch-square ceramic block with a hair-thin electromagnetic core, can't fly around or over dust-sized obstacles. Instead the head collides with the particle, gouging it into the disk's surface. The friction generates heat, which melts the epoxy-like surface and practically glues the head to the disk. While the now-blinded head vainly searches for data it can no longer read, the disk surface is ripped apart.

As the result of such disasters and the subsequent loss of irreplaceable information, many businesses have learned the virtues of extreme cleanliness in their computer rooms and the value of backup storage. However, all is not lost when a "head crash" occurs. David A. Brown, a computer scientist and president of Data Recovery in Los Angeles, has developed a process that restores damaged magnetic disk surfaces to manufacturers' specifications. In a proprietary process, Brown smooths the bumpy areas so that a recording head can get past the damage into areas where data remain. "We can't put data back once they've gone, but we can make any data that are still on the disk available to the user," he says.

Brown says he would be happier if fewer people needed his services. Nevertheless, hundreds of computers are being installed in "dirty rooms," and businesses are in danger of losing valuable data. Brown stresses, "Cleanliness is critical."

Earth Sciences

Reading seismic history in tree rings

One critical bit of information that researchers need if they are to predict the probability of earthquakes with any accuracy is the frequency with which the quakes have occurred in a given location. In places such as China, where the historical record is long and well-understood, the frequency, or recurrence interval, is easier to establish. But for some quake-prone areas the seismic history is elusive. Researchers at the Lamont Doherty Tree Ring Laboratory in Palisades, N.Y., suggest that trees are stressed when the earth moves, and that their response to earthquakes is recorded in annual growth rings.

"The concept has been kicking around for a while, but no one has made great use of it," says Gordon Jacoby. He and researcher Linda Ulan took core samples from trees in the Icy Cape in the Yakataga, a seismically active region of Alaska. They found that until 1899, when a strong quake is known to have occurred, some of the trees were on the shoreline. When the quake occurred, the land was uplifted, and since then the trees have lived in a relatively protected environment, a condition displayed by the more rapid growth rate revealed by the rings. Jacoby says tree rings also show trees' efforts to grow vertically after they were tilted by ground movements. If a root system crosses a fault or is near one, the quake may cause a disruption in growth that will be indicated by a smaller ring for that year.

The study of tree rings is usually applied to climate problems, and the new use is not without controversy. For example, Jacoby says, previous geological studies have not indicated that uplift occurred in this area of Alaska during the 1899 quake, but he believes his findings can be defended.

One difficulty in the approach is that trees respond to a variety of stimuli and it can be hard to sort out the specific causes of changes in the tree rings, which grow in identifiable increments each year. In the Alaska studies the researchers also looked at trees from 400 to 800 years old that had not been disturbed by the quake. These trees are in the same area and are the same age as the uplifted trees, Jacoby says, but show no increase in growth rate following the quake. He says that so far there is too little information to allow estimates of earthquake magnitude, but that such data could be derived if it were known over how large a region trees responded to a given quake.

Lightning and sandy soil

Residents of Florida, where lightning storms are as commonplace as palm trees and beaches, call their state the "lightning capital of the world." Power outages are frequent there, and repairs to electrical systems and transformers routinely cost far more than power companies expect to spend. In the course of doctoral research at the University of Florida at Gainesville, Maneck Master, now with Bell Laboratories in Holmdel, N.J., developed a theory to explain why protective devices such as surge arresters are inadequate and why estimates for voltages induced on overhead wires in Florida might be wrong.

It is well known that lightning need not directly strike a wire in order to induce unwanted "transient" surges of electricity (SN: 11/27/82, p. 346). In Florida the problem of frequent lightning is compounded by the composition of the loose, sandy soil — a factor that has not been considered sufficiently by previous theories, Master says. When lightning strikes well-packed, moist soil, the electromagnetic field generated is mostly vertical. When it strikes the dry and sandy Florida soil, the electrical field tilts and the horizontal component becomes more important. Even a small increase in the horizontal element can have major effects because the charge is more likely to enter the long, horizontal telephone wires. Master says that the finding might be an important consideration in designing power systems, television cables, and other electrical units that rely heavily on horizontal, above-ground wires.