Snaring hidden explosives with a neural net

Perhaps, as one airline official suggests, the only sure way to stop the epidemic of airplane bombs is to send luggage by rail and have everyone fly naked. But a novel device that combines the precision of gamma-ray detectors and the learning ability of neural networks may offer the next best alternative.

Physicist Patrick M. Shea reported at last week's International Joint Conference on Neural Networks in Washington, D.C., that a new bomb-detection device spotted 95 percent of the simulated explosives attached to luggage in recent airport tests and mistakenly identified explosives in only 2 percent of the weapon-free luggage – half the false-alarm rate of a similar model lacking the neural network component. Shea says the detection system, known as a thermal neutron activator, represents one of the first successful commercial uses of a neural network. By late July, he and his colleagues at Science Applications International Corp. of Santa Clara, Calif., will install their device at New York's John F. Kennedy International Airport for a year's study. The Federal Aviation Administration has ordered the installation of five more of the $950,000 detectors by January at other airports in the United States and overseas.

Although the researchers only recently added the neural network, the bomb detector itself relies on a technique long established in nuclear physics. A cloud of low-energy neutrons bathes each suitcase moving along a conveyer belt through the machine, which is about the size of an airport X-ray detector. As atomic nuclei in the luggage absorb the neutrons, each element emits gamma rays of a characteristic energy. Analysis of the gamma rays provides an element-by-element fingerprint of the luggage contents. Researchers say the technique is particularly useful for detecting nitrogen-rich compounds, such as explosives, because neutron-activated nitrogen emits a telltale 10.8-million-electron-volt gamma ray, more energetic than that of any other element.

In 1987, the California researchers used ordinary computer logic to determine whether such gamma-ray data indicated the presence of a bomb. The device detected 95 percent of the simulated weapons in 40,000 pieces of luggage with a false-alarm rate of 4 percent. This year the group took a leap forward, inserting into its detector an electronic circuitry that mimics the connections between nerve cells in the brain. This type of circuitry, called a neural network, can handle data on such luggage features as size, shape and weight without having to presort the information, yielding more accurate decisions about which suitcases may contain bombs, Shea says. Moreover, an additional layer of electrical connections between input and output units allows the researchers to train the system to give increasingly reliable answers after repeated trials with test luggage. "It's like hitting the network with a stick," says Shea of the training process, in which error signals provide feedback that prompts the system to adjust its electrical connections and make a better decision on the next try. – *R. Cowen*

Proposal seeks wider access to AIDS drugs

An influential federal health official has proposed easing restrictions on certain experimental AIDS drugs, a move that would allow many AIDS patients access to the latest therapies. Groups representing AIDS patients hail the proposal, but some scientists worry that patients will no longer willingly participate in clinical research trials if they can easily obtain a new drug through their own physician.

Anthony S. Fauci, director of the National Institute of Allergy and Infectious Diseases, outlined his proposal last week at the HIV Treatment Awareness Week meeting in San Francisco. The plan has been well received by Food and Drug Administration officials.

Under the current system, AIDS patients can receive experimental drugs by enrolling in clinical trials designed to test the drugs' safety and efficacy. Many AIDS advocacy groups contend this system takes years and excludes many patients who can't meet a strict study protocol.

Fauci's plan would not supplant FDA's evaluations of experimental drugs but would create a separate program under which doctors could give AIDS patients certain experimental treatments approved by FDA on a case-by-case basis. Drugs in the program would have to pass FDA's Phase I toxicity evaluation but would be available for general dispersal while FDA continued to test the experimental drug's efficacy in a Phase II clinical trial.

Fauci's spokesman says many details of the plan have to be worked out, including safeguards to protect patients from hastily approved drugs that later prove unsafe.

Drug researchers worry that such a plan might mean a dearth of clinical trial participants. Fauci says he believes some AIDS patients will continue to participate in clinical trials in the hope that rigorous monitoring will translate into better health care and a better prognosis.

FDA this week put Fauci's plan in action by allowing wider distribution to AIDS patients of r-erythropoietin, an experimental drug undergoing tests as a treatment for the severe anemia suffered by some AIDS patients who are taking zidovudine, commonly known as AZT.

Also this week, the General Accounting Office (GAO) released a report contending that methods used to gauge the U.S. AIDS epidemic greatly underestimate the number of people who will develop the disease. Although statistics vary widely, the Centers for Disease Control in Atlanta projects that cumulative AIDS cases will total 185,000 to 320,000 by the year 1991. GAO's research suggests the number will be closer to 480,000. – *K.A. Fackelmann*

Chemical waves curl around tiny globes

A barely visible streak of blue chemicals appears spontaneously at the north pole of a red, translucent globe the size of a small peppercorn. It winds southward behind the globe and emerges at the front just north of the equator. The spiraling blueness then dips into the southern hemisphere as it crosses the tiny orb's front, once again disappearing to the other side. Even before the streak spirals into itself and vanishes at the south pole, another one pierces the red-again north pole and begins its own twisting journey south.

Through a microscope, chemists Kenneth Showalter and Jerzy Maselko of West Virginia University in Morgantown spy these and even more exotic periodic chemical happenings on the surfaces of polymeric beads immersed in unusual chemical solutions. "It's a psychedelic effect," Showalter says.

The bead surfaces harbor systems of oscillating reactions that alternate between two colors. By getting the reactions to occur on spherical surfaces for the first time, the researchers can elicit behaviors impossible for such chemical systems in their more common experimental condition – spread onto a flat petri dish. The scientists report their observations in the June 22 NATURE.

For years researchers have studied these odd series of chemical reactions, which produce concentric-circular and spiral patterns that oscillate both in space and in time. The mathematical equations describing the reaction dynamics are nearly the same ones describing such phenomena as propagating flame fronts inside an engine's piston, the complex and contrary motions of a heart teetering toward cardiac arrest and the ebbs and flows of animal populations, notes Arthur T. Winfree of the University of Arizona in Tucson.

Showalter adds that studying these oscillating reactions on nonflat geome-

tries could lead to insights about biological processes that operate according to the same dynamical rules that govern the oscillating reactions. "It's just a lot easier to study the chemical systems than the biological systems," he says.

The most studied chemical oscillator—named the Belousov-Zhabotinsky or B-Z reaction after its Russian discoverer and developer, respectively—involves a complex interplay in acidic solutions of organic molecules like malonic acid, inorganic ingredients such as the negatively charged bromate ions, and a metal-containing catalyst that doles out or takes back an electron at different phases of the oscillation. The rapidity of the oscillations depends on the relative concentrations of the solution components, and the specific behavior at a point in the solution reflects variations in the local chemical environment.

Instead of allowing the catalyst to roam the solution freely, the Morgantown scientists load ferroin, an iron-containing catalyst, onto the roughly 1-millimeter beads. The beads' overall negative charge also keeps a major B-Z reactant—bromate ions — from penetrating the beads' interiors. "This forces the reaction to occur at the surface," Showalter explains. "We go from bead to bead looking for interesting behavior." *— I. Amato*

Unraveling sleep disorders of the aged

An overactive sympathetic nervous system may prevent elderly people from getting a good night's sleep, according to Seattle researchers who suggest that the sympathetic nervous system, which is responsible for arousal, increases its activity with age. The scientists hope their work will eventually spawn new treatments for an age-old problem.

Michael V. Vitiello of the University of Washington and his colleagues studied nine healthy men aged 22 to 25 who were good sleepers. Participants checked into a sleep laboratory for three 96-hour periods, receiving one of three experimental diets designed to manipulate the sympathetic nervous system. Diets consisted of hospital food altered to contain 500 milligrams of sodium per day (low), 2,000 mg of sodium per day (moderate) or 5,000 mg of sodium per day (high).

The researchers used the low-sodium diet to boost activity of the sympathetic nervous system, hoping to mimic sleep disturbances seen in the elderly. A low-sodium diet triggers water loss from the body, which results in a blood pressure decline, Vitiello explains. The sympathetic nervous system senses the body's water loss and releases norepinephrine, a neurotransmitter that constricts blood vessels, thereby maintaining blood pressure. Vitiello and his colleagues speculated that the increased activity would keep their young subjects tossing and turning at night—a time when the sympathetic nervous system typically slows down.

In studying the sleep patterns of the three groups, the team found that men on the low-sodium diet awoke an average of nine times during the night, while men in the moderate- and high-sodium groups awoke five times. The low-sodium group spent about 53 minutes awake per night, whereas men in the other groups were awake for about 22 minutes. Moderate- or high-sodium subjects spent about 95 percent of their time in bed asleep; low-sodium subjects had a sleep efficiency of only 88 percent.

"Perhaps it is the sympathetic nervous system that is contributing to the disturbed sleep of the elderly," Vitiello reported last week at the annual meeting of the Association of Professional Sleep Societies in Washington, D.C. "But the conclusions aren't that one should go out and eat a lot of salt in order to sleep better. That would be the last thing I would want people to do."

Vitiello points out that the sodium manipulation in his study was for experimental purposes only. There is no evidence showing that a high-salt diet would help elderly people sleep better over the long run, and very salty diets can contribute to other problems such as high blood pressure, he notes.

Vitiello's group has carried the research one step farther by giving elderly men diets with varying sodium contents. The researchers have not yet analyzed the data, but they postulate that elderly men on a low-sodium diet will experience a deterioration of their sleep. Exercise may be one possible remedy, says Vitiello, noting that physical activity is thought to subdue the sympathetic nervous system.

— K.A. Fackelmann

Pacific plankton outdo land pollution

Sulfate pollution generated on land can ride the wind for great distances, eventually dropping into remote reaches of the ocean. Yet long-term measurements on Pacific islands reveal that these well-traveled particles are far less numerous than natural sulfate compounds in the air over the ocean.

This new finding bolsters a recent theory — now attracting considerable scientific attention — that tiny ocean organisms called plankton exert a powerful influence on Earth's climate.

In the June 29 NATURE, researchers describe the sulfate study and a similar study on nitrate. These particles, which form the principal components of acid rain over continents, reach the atmosphere through fossil-fuel combustion and other industrial and natural processes. As part of an international experiment in the early 1980s, Joseph M. Prospero and Dennis L. Savoie of the University of Miami analyzed weekly air samples at 13 island stations for seven years in the North Pacific and five years in the South Pacific.

Data from the network show that the sulfate and nitrate spread unevenly over the oceans, say Prospero and Savoie. Nitrate concentrations were lowest at American Samoa and other stations in the central South Pacific while reaching their highest levels in the North Pacific. Using the southern figures as a measure of "background" nitrate concentrations, the researchers calculated that the North Pacific stations received three times the background amount.

This leads Prospero and Savoie to conclude that 40 to 70 percent of the nitrate over the central North Pacific comes from continental sources. Noting that nitrate amounts swung with the arrival of Asian dust from continental storms, they say this continental nitrate originated in Asia.

Because both sea salt and plankton yield large amounts of natural sulfur compounds, the researchers had to isolate these sources to measure the continental sulfate contribution. In doing so, they showed that biological sulfate greatly outweighed the continental sulfate at the remote stations, even though industry emits more sulfur than do ocean organisms. At Midway, where continental sulfate levels were particularly high, biological sulfate was four times as abundant.

This finding supports the idea that plankton help regulate the climate by emitting key sulfur compounds that convert to sulfate. According to the theory, these sulfates create nuclei for cloud particles and increase cloud reflectivity, limiting the amount of sunlight reaching the ocean (SN: 12/5/87, p.362).

Last year, Stephen E. Schwartz of the Brookhaven National Laboratory in Upton, N.Y., argued that biological sulfate has little climate effect (SN: 12/10/88, p.375). He noted that while industry is concentrated in the Northern Hemisphere, the great amounts of industrial sulfate have produced no noticeable effect on that hemisphere's clouds or climate. The data from the island stations counter Schwartz's argument by showing that marine concentrations of industrial sulfate do not rival biological-sulfate levels. Therefore, Prospero says, the industrial sulfur should not exert as much control over cloud reflectivity as Schwartz supposed. *— R. Monastersky*