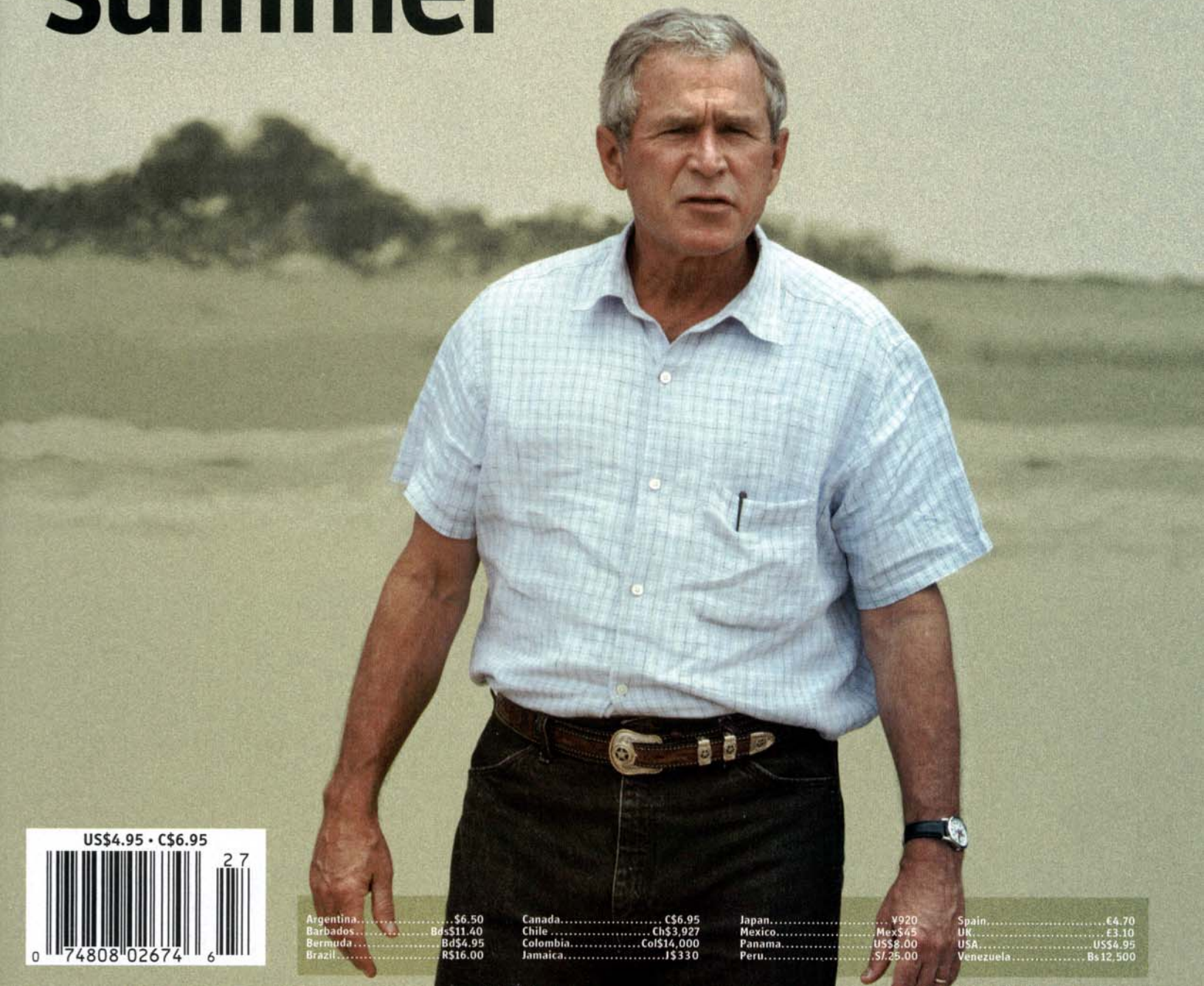
The Economist

JUNE 25TH–JULY 1ST 2005 www.economist.com

George's long, hot summer



US$4.95 • C$6.95

0 74808 02674 6 27

Argentina	$6.50	Canada	C$6.95	Japan	¥920	Spain	€4.70
Barbados	Bds$11.40	Chile	Ch$3,927	Mexico	Mex$45	UK	£3.10
Bermuda	Bd$4.95	Colombia	Col$14,000	Panama	US$8.00	USA	US$4.95
Brazil	R$16.00	Jamaica	J$330	Peru	S/.25.00	Venezuela	Bs 12,500

of the early universe, Dr Trotta and Dr Melchiorri have now put his idea to the test. They did so by varying the model's parameters—particularly the amount of ripple in the neutrino background—and comparing the outcome with data on the microwave background and the large-scale distribution of galaxies. They found, as they had hoped, that the model universes which most resembled the real one were those in which the CNB most resembled what cosmologists predict that it should look like. The signature of the CNB does, in other words, appear to be there.

At the moment, Dr Trotta and Dr Melchiorri have done little more than prove the point. But that could change quite fast. With better CMB data from new satellites, this approach should allow cosmologists to decide which, if any, of the various exotic theories about the very early universe is actually true. For instance, they have recently come to believe that the universe is dominated by a mysterious phenomenon that they have dubbed "dark energy". If neutrinos interacted with this dark energy a few seconds after the Big Bang, it might have produced a detectable effect on the ripples in the neutrino background. These would give clues about what it really is.

That alone would be a prize worth having. But besides any scientific importance, the idea of seeing a snapshot of the universe not merely as an infant, but as the cosmological equivalent of a newly fertilised egg, has a glory all of its own. ■

Combating cancer

Networking

Picking the best treatments for cancer patients

WHILE particle physics can be esoteric, its practitioners are keen to show it has practical applications. They invented the world wide web. They also contributed to a number of advances in medicine, among them positron-emission tomography, a body-scanning technique. Now, as if to strengthen the case, a group of particle physicists led by Robin Marshall of the University of Manchester, in Britain, has applied its knowledge of information technology to show how computer programs known as neural networks can help doctors to choose the best treatments for people with cancer.

Unlike a conventional computer, which takes data, processes it using an algorithm and generates a definite answer, a neural network learns to create a range of answers from a range of inputs. To do this, it is "taught" by being fed a series of training inputs and then told what the answer should be in each case. The network adjusts the weighting of its internal connections to try to retain the correct matches as far as possible. Once the teaching process is complete, the network can be used to calculate answers from new inputs.

Like many in his field, Dr Marshall uses neural networks to discard the huge amounts of boring data produced in particle colliders and to identify the interesting events. The network learns to associate a particular range of inputs with interesting collisions and to ditch the rest. He has now turned this expertise to the medical field, following a chance meeting with Sir Alfred Cuschieri, an oncologist at Ninewells Hospital in Dundee.

Ninewells has detailed records on thousands of patients with colorectal cancer. These records contain a wide range of information such as each patient's age, sex, type of treatment, size of tumour and eventual fate. Dr Marshall realised that a neural network could be trained with this information to calculate the survival chances of other people with the same condition. The machine would learn to associate certain ranges of patient profiles with particular survival probabilities.

Dr Marshall and Sir Alfred, together with some colleagues from Manchester and Dundee universities, selected those records that contained enough data to create a detailed profile of a patient at the beginning of his treatment, and to follow his progress over the subsequent five years. They then used 1,558 of these records to train a neural network. In each case, the input was 16 pieces of data that defined the state of the patient. The output (ie, what the network was trying to learn to predict) was the patient's fate—in other words, whether he died over the course of the five years and, if so, when.

The researchers, who will publish their work in a forthcoming issue of *Concurrency and Computation: Practice and Experience*, then tested the trained network by using the same 16 parameters from each of the remaining 1,220 records as the input, while withholding information about the survival of the patient. They found that, in 90% of cases, the time at which the neural network predicted that a patient's chances of survival would fall below 40% was within three months of the actual time of death of that patient.

According to Sir Alfred, this system is ideally suited to predicting the survival chances of individuals. He says that the statistical techniques currently used by doctors to calculate a person's chances of surviving a disease such as cancer are a blunt instrument. By contrast, the neural network created at Manchester enables them to give individual prognoses, so they do not have to rely on crudely defined average chances of survival.

Once the project's researchers have verified the reliability of their neural network, they intend to make it accessible over the internet. Doctors will be able to enter their patients' parameters and generate prognoses. More importantly, they will be able to compare the effects of different treatments by varying the relevant inputs.

The researchers also believe that their system could be applied to the treatment of a variety of other chronic disorders, such as heart disease and diabetes. That would create further evidence that particle physicists do live in the real world, at least some of the time. ■

Simian economics

Monkey business-sense

Monkeys show the same "irrational" aversion to risks as humans

ECONOMISTS often like to speak of *Homo economicus*—rational economic man. In practice, human economic behaviour is not quite as rational as the relentless logic of theoretical economics suggests it ought to be. When buying things in a straight exchange of money for goods, people often respond to changes in price in exactly the way that theoretical economics predicts. But when faced with an exchange whose outcome is predictable only on average, most people prefer to avoid the risk of making a loss than to take the chance of making a gain in circumstances when the average expected outcome of the two actions would be the same.

There has been a lot of discussion about this discrepancy in the economic literature—in particular, about whether it is the product of cultural experience or is a

Cracking an economic problem

reflection of a deeper biological phenomenon. So Keith Chen, of the Yale School of Management, and his colleagues decided to investigate its evolutionary past. They reasoned that if they could find similar behaviour in another species of primate (none of which has yet invented a cash economy) this would suggest that loss-aversion evolved in a common ancestor. They chose the capuchin monkey, *Cebus apella*, a South American species often used for behavioural experiments.

First, the researchers had to introduce their monkeys to the idea of a cash economy. They did this by giving them small metal discs while showing them food. The monkeys quickly learned that humans valued these inedible discs so much that they were willing to trade them for scrumptious pieces of apple, grapes and jelly.

Preliminary experiments established the amount of apple that was valued as much as either a grape or a cube of jelly, and set the price accordingly, at one disc per food item. The monkeys were then given 12 discs and allowed to trade them one at a time for whichever foodstuff they preferred.

Once the price had been established, though, it was changed. The size of the apple portions was doubled, effectively halving the price of apple. At the same time, the number of discs a monkey was given to spend fell from 12 to nine. The result was that apple consumption went up in exactly the way that price theory (as applied to humans) would predict. Indeed, averaged over the course of ten sessions it was within 1% of the theory's prediction. One up to *Cebus economicus*.

The experimenters then began to test their animals' risk aversion. They did this by offering them three different trading regimes in succession. Each required choosing between the wares of two experimental "salesmen". In the first regime one salesman offered one piece of apple for a disc, while the other offered two. However, half the time the second salesman only handed over one piece. Despite this deception, the monkeys quickly worked out that the second salesman offered the better overall deal, and came to prefer him.

In the second trading regime, the salesman offering one piece of apple would, half the time, add a free bonus piece once the disc had been handed over. The salesman offering two pieces would, as in the first regime, actually hand over only one of them half the time. In this case, the average outcome was identical, but the monkeys quickly reversed their behaviour from the first regime and came to prefer trading with the first salesman.

In the third regime, the second salesman always took the second piece of apple away before handing over the goods, while the first never gave freebies. So, once again, the outcomes were identical. In this case, however, the monkeys preferred the first salesman even more strongly than in the second regime.

What the responses to the second and third regimes seem to have in common is a preference for avoiding apparent loss, even though that loss does not, in strictly economic terms, exist. That such behaviour occurs in two primates suggests a common evolutionary origin. It must, therefore, have an adaptive explanation.

What that explanation is has yet to be worked out. One possibility is that in nature, with a food supply that is often barely adequate, losses that lead to the pangs of hunger are felt more keenly than gains that lead to the comfort of satiety. Agriculture has changed that calculus, but people still have the attitudes of the hunter-gatherer wired into them. Economists take note. ■

Safety

Burning ambitions

PARIS

A Russian-designed system for surviving fires in tall buildings

THE Paris air show is a notoriously chaotic affair. This year's, which finished on June 19th, was no different from usual. But in a quiet corner of the show, a new way of clocking up air miles was to be found. It looks like a small, orange, inflatable swimming pool with a pointy underside. And strapped inside it is a Biggles-like doll complete with goggles, moustache and flying scarf. It is an escape-pod for people trapped in tall, burning buildings. And it is the product of the Lavochkin Association, an aerospace firm based in Khimki, near Moscow.

There is, at the moment, no convenient way to leave a tall building if the emergency staircases are on fire and the fire brigade has not arrived or its ladders will not reach. Nor are conventional parachutes an answer. As is well known to participants in the sport of Base Jumping (a mind-bogglingly dangerous activity that involves parachuting from static objects), parachutes have problems when launched from tall buildings. For a start, they may not have time to open properly. Even if they do, they can get snagged on the way down. And on top of that, if a building is burning they are liable to catch fire. Hence the Lavochkin escape pod—or "rescue system", as the firm prefers to call it.

According to Yuri Boulanov, one of Lavochkin's representatives at the air show, the idea is to create a cheap, inflatable structure that can be compressed into a backpack, like a parachute. The pod is designed with an inflatable tube around its edges, which should cause it to bounce off the walls of a building. And the final version will be made from some, as yet unspecified, fire-retardant material. As a bonus, and unlike a parachute, it will operate safely from altitudes of five metres and above—which would make it suitable even for the top floors of houses.

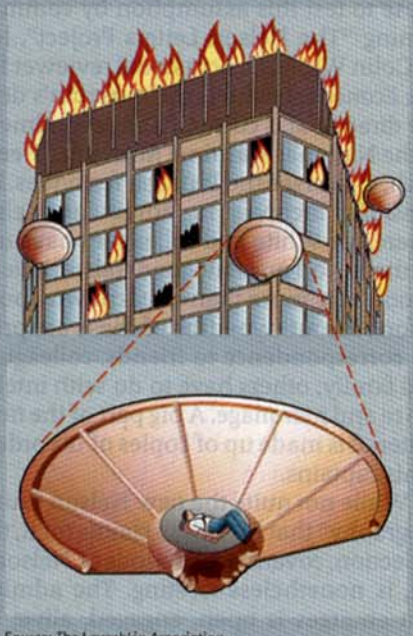
In an emergency, someone wishing to leave in a hurry would strap on the backpack and jump, pulling a ring as he did so. The pod would inflate, surround him instantly and bear him gently to the ground. At least, that is what happens to the digital simulation in the company's promotional video.

The pod on display at Lavochkin's stand was actually a one-metre diameter prototype. The full-scale device, currently undergoing tests with a sensor-loaded dummy as its passenger—is six metres across and should be able to carry someone weighing up to 120kg. Mr Boulanov says the commercial version should cost around $1,000.

If it all sounds unlikely, it is worth remembering that it is now possible to lob a spacecraft all the way to Mars and have it land safely using an inflatable shell similar to Lavochkin's. Now all that is needed is some way of getting through the sealed windows with which most tall building are glazed.

Baling out

How the Lavochkin rescue system works



Source: The Lavochkin Association