In this issue

Rain-interrupted cricket matches: The Jayadevan challenge to Duckworth–Lewis

The second biggest obstruction that comes in the way of cricket-lovers enjoying a good and interesting cricket match is Rain (the biggest, of course, is the pettiness of the international and some of the national governing bodies). The exasperating uncertainty introduced by impending rain is very different from the inherent glorious uncertainty of cricket. Coming to think of it, in the good old days of test matches, the display of special skills of batting and bowling on a sticky wicket (or even a tactical manoeuvre of an unexpected declaration) did, in fact, add a certain charm and drama to rain-affected games. There are no such positive, compensatory factors for the 'instant', limited-overs version of the game, however. Here, rain threatens to lead to a 'no result' outcome, and the chief attraction of the limited-overs matches is that there is supposed to be a guaranteed result!

There can be no doubt that a match would be a literal wash-out if, due to rains, not even 25 (instead of the scheduled 50) overs of play for either of the teams is possible. However, what if the first team bats for the full quota of 50 overs, but for the second team, only say 45 overs are available? The most obvious solution for generating a result, and yet making it a fair match for both the teams is to reduce the target from the runs scored by the first team to something smaller. The (sometimes literally!) million dollar question is: what is the best procedure to arrive at such a fair target? Some of the early attempts to reset the targets (e.g. using the most productive overs) led to disastrous results. The most famous example is the England–South Africa semi-final match during the 1992 World Cup, where the application of one such rule suddenly changed the target for South Africa from 22 runs in 13 balls to 21 runs in one ball. The sight of the tearful Brian Macmillan leading his teammate off the field was unforgettable! On the positive side, this outcome provided a much-needed impetus for devising better methods for resetting targets. A variety of people, ranging from an Australian high-energy physicist to a South African schoolboy, have come up with some very imaginative solutions to this problem. The official procedure now (since September 1999) in use is the Duckworth–Lewis (D/L) method, invented and popularized by these two statisticians. Published in the prestigious *Journal of the Operational Research Society* in 1997 (and first implemented in England in the same year), the method expresses the runs to be scored as a function of two resources – overs to be faced and wickets in hand. Arrived at using an extensive analysis of a large body of data and based on a sound mathematical formulation (exponential decay type of equations), the D/L method is very well supported (explanatory handbooks and computer programs are available for a moderate price). The method seems to have given quite reasonable results in many circumstances (in the celebrated England–South Africa match mentioned above, the D/L method suggests a much less preposterous target of nine runs in the last remaining ball). Amazingly, however, the exact mathematical functions that are at the heart of the D/L method are not available for scrutiny or independent validation – 'commercial confidentiality prevents the disclosure of the mathematical definition of these functions . . .', explain Duckworth and Lewis in their article. There have also been occasional complaints of D/L targets being somewhat unfair. Perhaps the most famous one is of the match in February 2002, where England scored 193 for six wickets in 40 overs in a rain-curtailed first innings, and the D/L method set a target of 223 for New Zealand!

In the article on **page 577** of this issue, V. Jayadevan presents his ingenious invention – a viable alternative to the D/L method. Under development for the last many years, recently perfected and modified to handle any number of interruptions at any stage of the game, Jayadevan's method relies on a regression-based mathematical model, arrived at using data from a number of closely-fought matches. Being a civil engineer by training and an engineering researcher by profession, Jayadevan has brought a very practical approach to resetting targets in interrupted matches. Unlike the commercial confidentiality reminiscent of proprietary software, Jayadevan's method, in the finest tradition of open-source-software, has been described as completely as possible, within the constraints of the space available for an article in a scientific journal. A most enjoyable, detailed and scholarly comparison of this and other methods has been described in the delightful articles (fortunately, easily available on the web) by Srinivas Bhogle. In addition, a table in Jayadevan's article in the current issue provides a list of examples wherein his method does seem to be superior to the D/L method (e.g. setting a more reasonable target of 212 for New Zealand against England in the match mentioned above). Fortunately, there has been considerable interest and encouragement from a number of Indian authorities (including Sunil Gavaskar), and one hopes that the Jayadevan method will emerge as a serious challenge to the D/L method. Over to Jayadevan on **page 577**.

N. V. Joshi

Whose 'fault' is it?

The rubble of the devastation caused by the Bhuj earthquake in 2001 drew the attention of scientists, to the fact that at least 22 such quakes were recorded previously in the vicinity of the current disaster. At least one, in 1819, caused significant damage. Such observations help geo-scientists understand the nature of surface effects caused by large quakes, leading to formulation of guidelines for predicting seismic hazards. For a sleuth attempting to reconstruct seismic and geophysical history, there are many unknowns. Traditionally one looks for samples suitable for dating and physical assays. Then one has to ascertain the magnitude of the earthquake based on, as Kusala Rajendran *et al.* explain (**page 603**), the thickness and the spread of the sand blows. Interference from cyclonic storms, heavy rain or other erosions could come in the way of accurate measurements. The authors explain the process of liquefaction causing the fluidization of the sand mass piercing through the usual clay mantle and the craters and sand dikes caused after the earthquake. Such field measurements augment the calibration plots to estimate the magnitude of earthquake. This work fills in several gaps in Indian seismology and illustrates some of lessons of the Bhuj earthquake.

S.G.

Simulation of NOT gates with bacteriorhodopsin

Bacteriorhodopsin (bR), a seven-helix transmembrane protein of molecular mass of 26 kDa, serves as a model for studying ultrafast switches based on isomerization of all-*trans* to 13-*cis* in a protein induced by light. It also belongs to a family of retinal-containing proteins serving diverse cellular signal transduction responses to an optical stimulus. The protein is usually isolated from the cell-membranes of halophilic archaeobacteria, *Halobacterium halobium*. The side-chain of lysine 216 of this protein is bound covalently by a protonated Schiff base to a retinal molecule chromophore. Absorption of light induces isomerization of all-*trans* retinal to the higher energy 13-*cis* conformation, initiating a chain of photo-excitatory events characterized by the presence of several transitional states of the molecule.

Electrical circuits are switched with traditional logic gates made of silicon-based transistors. Switching of conformational states by chemical, electro-chemical, electro-magnetic, thermal, optical or even mechanical means depending on the type of the receptor and the type of the signal transduced by biomolecules may be used in future molecular electronics. Roy *et al.* (**page 623**) utilize the conformational states of bR to realize all-optical switching to fabricate logic gates based on biomolecules. Such systems could work when conformationally active molecules of bR, which respond to optical cues, are impregnated on a solid matrix of polymers. The fine-tuning of the response characteristics could be achieved by modifying the protein.

The authors develop computer simulations by solving the rate equations assuming a single M state and ignoring the J state intermediate. The photochemical cycle is described in terms of the time rates of population densities of the various intermediates. Rate equations are solved numerically under reasonable approximations for the rate constants and the absorption cross-sections and a film thickness of 30 μm. An important feature in this work is the simulation of an inverter (NOT) logic gate. This configuration shows a time-delay of about 4.3 ms corresponding to the gap required for transition from the B to the O state during the photocycle of bR. When NOT is here, can NOR and NAND be far behind?

S.G.

Immunopathogenesis in kala-azar

In the search for a mechanistic understanding of immunopathogenesis during the infection of *Leishmania donovani* causing kala-azar, P. Kumar *et al.* (**page 631**) attempted a correlation in the rate of pinocytosis of the monocytes isolated from 9 normal healthy individuals and 15 active visceral leishmaniasis (VL) patients. Experiments were also carried out in presence of a mitogenic stimulant, lipopolysaccharide. The authors conclude that in active VL patients, in comparison to healthy controls the pinocytic rate is lower. Changes were not significant in the presence of lipopolysaccharide. The authors suggest that infection causes down regulation of macrophage activation during active visceral leishmaniasis.

Early hominid behaviour in Karnataka

Paddayya *et al.* (**page 641**) report the results of survey and excavations at Isampur in northern Karnataka (India) during 1997–2001. Electron spin resonance dating experiments performed on fossil samples of herbivore teeth suggest the minimum age of the site to be more than 1.2 Ma, making Isampur the oldest known site in India. Extensive excavations yielded a large quantity, at least 15,000 artifacts, of lithics and suggested a location comprising four contiguous small localities (500 m^2). In conjunctions with other findings from around the site, it is believed that Isampur probably served as a hub for manufacturing and occupation, a primitive city market. Perhaps the early hominids radiated uplands and across the valley during their daily activities.

S. Ganguli