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The patterns of tiny feet

Professor Ian Stewart, in New Zealand on a Seelye Fellowship late last year, tells the story of the bet that launched a new branch of science.

The Governor of California bet $25,000 in 1870 that a trotting horse is completely off the ground at some point.

"You can't tell with the naked eye," says Stewart, "but the governor's friend Edward Muybridge invented a camera that could freeze very fast motion and trotted a horse past a line of these cameras. And it was off the ground at one point." Muybridge went on to photograph the gaits of every large animal he could, down to dogs and cats, founding the branch of science called Gait Analysis.

From fossilised dinosaur footprints and skeleton structure, Gait Analysis has been able to analyse how these animals must have moved, and how quickly. And by analysing how people move, it is possible to spot problems before they become serious and deal with them. Stewart describes this as a fascinating application of the mathematics of rhythmic patterns.

One result of Stewart's work in the area was a prediction that the number of sinusoidal waves moving along a centipede would be either an integer or half an integer. Photographs bear out the prediction.

Stewart is a Professor of Mathematics at Warwick University in the UK. He started out as an abstract algebraist, and working on the dynamics of symmetry as a way to get closer to applied mathematics. "There is a lot of potential for dynamic systems modelling in biology. Biologists have realised that it's not enough to list the interactions of chemicals and genes, we need to look at how the whole system works - and they're maths questions."

"Networks of neurones create the rhythms underlying patterns of gait," says Stewart. "The vestibular system in our ears, three semi-circular canals, senses head movement and signals our neck and shoulder muscles to keep us balanced. We know the wiring diagram that sends those signals; it has an elegant mathematical structure. You can draw it on the surface of a cube, with canals at the centre of each of the six faces and eight muscle groups at the eight corners of the cube."

"Each canal sends inhibitory signals to the four nearest corners, and excitatory signals to the four furthest corners, so this symmetry group has 48 elements. When a neural system has a lot of symmetries, we can predict some of the dynamics because they are organised by the symmetries."

Stewart illustrates, with typical enthusiasm, the Fibonacci number sequence in nature; after two starting values, each number is the sum of the two preceding numbers.

Stewart is more widely known outside the mathematical world for his science fiction writing, and his best-selling books about the science of science fiction novelist Terry Pratchett's creation, Discworld. Stewart's position at Warwick involves responding to media queries on mathematics-related issues, and producing popular lectures and maths items for media, including internet podcasts. He has won several awards for his active popularising of mathematics and related science areas.

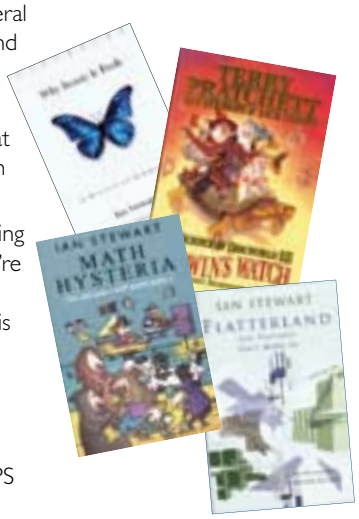
"A challenge is that a lot of people think the maths they did at school represents the whole subject; that very few new discoveries are made. It doesn't mean maths is frozen if you don't hear about them."

Stewart is enthusiastic about the public understanding of science, because "we need to get across why we're doing maths research, why it's interesting, and what they are getting out of it." One of the reasons for his visit was to share some ideas about building public understanding of maths.

"As soon as you start thinking of that, behind the scenes are massive amounts of maths, most of it quite new. Your MP3, CD and DVD players and GPS navigation, wouldn't work without error correcting code, for example."

"The Reed-Solomon code developed in the 1970s, based on very abstract algebra, is now the main error correcting system used in CD and DVD players. If you're driving and you go over a bump, this code makes sure the music comes out the way it should. The code can spot mistakes in the signal and transform it to what it should be. These devices work smoothly and seamlessly because of this underlying maths."

Jenny Rankine



See also

Stewart's podcasts at www2.warwick.ac.uk/newsandevents/audio/more/symmetry/