

Magazine

False starts

Remembrance of things past... rumination

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Last night there was an earthquake a few hundred miles away from where I am writing this in California, but it was strong enough to wake me. For a minute or so I could feel the building flapping and rocking and the furniture

shaking and moving around the room. This was followed by a deep silence, but I could not go back to sleep, and there is nothing like lying in bed after an earthquake has failed to get you, for a good rumination. Notice I did not say I lay in bed in the early hours thinking, because it took me years to realise that while I was schooling myself to be a theoretician, becoming a ruminator would be my best shot at it.

Thinking conveys the images of ice and steel and clear, pristine, hardness; whereas ruminating is much more meandering and slushy and not really directed at anything in particular. But because one can mull things over, and turn them upside-down and inside-out, many problems can be solved in this way, often by mistakes, by puns and other misdirections. I have always envied those people who took to mathematics and not only understood it but also knew how to use it. My school mathematics ended with quadratic equations and I spent many hours trying to learn calculus and other branches of mathematical analysis that I thought

I would need to become a scientist. But, somehow, it did not become really firmly lodged in my head.

Only the other day, I finally solved a problem that had occupied most of my ruminating time for the past year. It was a simple integration, but the answer I kept on getting was wrong, missing one term which I knew had to be there. I had left something out at one of the steps but I did not know what it was. I could, of course, state the answer, which nobody would query, but that would be like faking an experiment and one might be caught out by a naïve question at a seminar, such as “Where does k_2 come from?”

All of this was galling and no amount of analytical thought seemed to help. Then in a sustained bout of rumination, the answer oozed out. I had simply assumed one of the boundary conditions to be zero until I found it was not by running everything backwards, which was not quite correct but reached the right point anyway. I could then write it all down and feel very smug that I had achieved it all by myself and without cheating.

I discovered a long time ago that I was a geometer and that I needed diagrams and pictures to understand things. In the past few months I have been struggling to try to understand stochastic processes. I was doing pretty well with balls in an urn until I came across two things which I am sure are related: eigenvectors and eigenvalues. I have spent endless hours ruminating over these terms but, of course, it is hard to contemplate them without involving my friend Manfred Eigen, and all the more so, because I am sure he would know all about these matters and find my ignorance laughable. I may actually have to go and look them up in a textbook if I continue to make no progress by rumination. But I did sort out what the ergodic theorem is all about,

although I could not for the life of me understand the proofs offered in the textbooks, largely because I have not gone anywhere near something called measure theory.

Biology suits ruminators largely because, unlike physics, it has no formal mathematical structure that the thought mechanics can use. In the last fifty years or so of my misspent youth, I have wasted hours trying to master the many attempts to find such a structure. There was Woodger with his Axiomatic Method, replete with all the stuff from Principia Mathematica; Rashevsky (and many others) with heavy partial differential equations; and more recently, René Thom and others, pressing topology on us. I almost forgot chaos and something called the edge of chaos, and fractals, of course.

The wonderful aspect of biology is that one can combine rumination with having a go at the bench, or, as some may prefer to state it, theory and experiment. The art of the biologist is not only finding solutions to puzzles, but finding ways of showing that these are true. Sometimes the way itself takes almost a lifetime to develop, but it is always satisfying to get there in the end, especially if it all started from a vague rumination.

François Jacob likened the evolutionary process to “tinkering” or “*bricolage*”. This is a most un-French thought, which Jacques Monod, René Thom and all other righteous Cartesians would find ridiculous, perhaps even contemptible. But as an empiricist from the pre-genomic era, I find it almost exactly right, although not the end of the story. What sort of tinkering can it be? How can it produce non-trivial changes without making a complete mess of everything? Now there is something for you to ruminate about, the next time an earthquake wakes you up in the early hours.