ABSTRACT:
Many years ago, Mark Kac was consulted by biologist colleague Lamont Cole regarding field-based observations of animal populations that suggested the existence of 3-4 year cycles in going from peak to peak. Kac provided an elegant argument for how purely random sequences of numbers could yield a mean value of 3 years, thereby establishing the notion that pattern can seemingly emerge in random processes. (This does not, however, mean that there could be a largely deterministic cause of such population cycles.)

By extending Kac’s argument, we show how the distribution of cycle length can be analytically established using methods derived from random graph theory, etc. We will examine how such distributions emerge in other natural settings, including large earthquakes as well as colored Brownian noise and other random models and, for amusement, the Standard & Poor’s 500 index for percent daily change from 1928 to the present.

We then show how this random model could be relevant to a variety of spatially-dependent problems and the emergence of clusters, as well as to memory and the aphorism “bad news comes in threes.” The derivation here is remarkably similar to the former and yields some intriguing closed-form results. Importantly, the centroids or “centers of mass” of these clusters also yields clusters and a hierarchy then emerges. Certain “universal” scalings appear to emerge and scaling factors reminiscent of Feigenbaum numbers. Finally, as one moves from one dimension to 2, 3, and 4 dimensions, the scaling behaviors undergo modest change leaving this scaling phenomena qualitatively intact.

Finally, we will show how that an adaptation of the Langevin equation from statistical physics provides not simply a null-hypothesis for matching the observation of 3-4 year cycles, but a remarkably simple model description for the behavior of animal populations.

Host: Van Savage, Ph.D.
To receive e-mail seminar notices, contact David Tomita (dtomita@biomath.ucla.edu)