Fractal Dimension of Birds Populations Sizes Time Series

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A review has been made about time series fractal dimension and the techniques that can be used to estimate it. One of the most used is the Hurst coefficient, which can be calculated by several methods based on the assumption that the changes are random. This random or Brownian process means that for any step of time Δt, the increments $\Delta y(t) = y(t + \Delta t) + y(t)$ are:

a). Normal

b). Average zero

c). Variance proportional to Δt

Or what is equivalent to c): The successive increments $\Delta y(t)$ and $\Delta y(t + \Delta t)$ are not correlated.

This axiom can be generalized with the fractal process characteristic (Mandelbrot 1977, 1982) introducing the Hurst exponent H $(0 < H < 1)$ and replacing c) with:

c'). Variance proportional to Δt^{2H} (The random process has $H = \frac{1}{2}$)

d'). In a fractal process the successive increments has correlation ? time independent, defined by:

$$2^{2H} = 2 + 2\rho \left(-\frac{1}{2} < \rho < 1\right).$$

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This Hurst exponent can be estimated by several methods, like the moment of order two techniques or the range growth method (Hastings & Sugihara, 1993).

We have prepared a pascal program to calculate the Hurst coefficient by the different methods and used it with the populations sizes time series from three countries of North Europe extracted from Hustings (1992).

The assumption is that for time series with similar population sizes, the Hurst coefficient is a good measure of the population fluctuations and therefore it can be related with the more or less random extinction probability.

References

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