



Testing hypotheses on patterns of fossil occurrences: an unrestricted best test for inhomogeneous Poisson point processes

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Poisson point processes (PPPs) have been used for a long time to model the fossil record and to develop statistical methods to estimate extinction rates. Simple models that are based on constant rates are easy to handle, but tend to be unplausible. This is because there is a wide variety of influences on the fossil record that make a constant fossilisation rate an oversimplification. Methods following a time-dependent fossilisation rate given by a rate function are more flexible, but they often rely on a priori assumptions regarding the shape of the rate function. To avoid that problem, I did not aim at estimating rate functions, but at testing how plausible different rate functions are for empirical fossil data. The developed test is based on the theory of random measures and is optimal in the sense that it is a uniform most powerful test (UMP). The implementation of the test is based on a Monte Carlo method, combined with the simulation of samples from a PPP with a method similar to the inversion sampling method. Most importantly, there are no restrictions on the shape of the rate functions being tested and exact type 2 errors can be calculated.

The test can be applied to different questions arising in paleontology. One such question would be whether a species became extinct quickly or slowly, with phases of stagnation or recovery. Here, the test allows to compare all different shapes of extinction dynamics. Further, partial knowledge of processes driving fossilisation, such as depositional rate, can be incorporated into the test. Here, the test can be used to test hypotheses about the quantitative development of the unknown process over time.