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Detecting seismic events using Benford's Law

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The Benford's Law (BL) states that the distribution of first significant digits is not uniform but follows a logarithmic frequency distribution. Even if a remarkable wide range of natural and socioeconomical data sets, from stock market values to quantum phase transitions, fit this peculiar law, the conformity to it has deserved few scientific applications, being used mainly as a test to pinpoint anomalous or fraudulent data. We developed a procedure to detect the arrival of seismic waves based on the degree of conformity of the amplitude values in the raw seismic trace to the BL. The signal is divided in time windows of appropriate length and the fitting of the first digits distribution to BL is checked in each time window using a conformity estimator. We document that both teleseismic and local earthquakes can be clearly identified in this procedure and we compare its performance with respect to the classical STA/LTA approach. Moreover, we show that the conformity of the seismic record to the BL does not depend on the amplitude of the incoming series, as the occurrence of events with very different amplitudes result in quite similar degree of BL fitting. On the other hand, we show that natural or man-made quasi-monochromatic seismic signals, surface wave trains or engine-generated vibrations can be identified through their very low BL estimator values, when appropriate interval lengths are used. Therefore, we conclude that the degree of conformity of a seismic signal with the BL is primarily dependent on the frequency content of that signal.