Implicit Randomness of Seismicity and Predictability of Earthquake

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Analytical number theory shows that the probability for two integers chosen at random without common factors apart from 1 is $6/\pi^2$, which is related to the value of the Riemann-zeta function for reciprocal squares (Jones and Jones, 1998). It provides a numerical method to estimate the value of π by taking a large collection of random numbers and checking each pair for common factors. Earthquake records might also allow us a natural estimate of π.

Taking the temporal and spatial parameters of earthquakes as a source of random numbers, we counted up a number of pairs that are relatively prime, and set the proportion equal to $6/\pi^2$. An analysis of three datasets of earthquakes including earthquakes occurring in the mainland of China, South California, and all over the world, thus allowed us to estimate π with less than 3.0% relative deviation. We also tried to estimate π value with pairs of random integers set which were created from 128 major earthquakes ($m_b \geq 7.5$ or $M_S \geq 7.5$) around the world (from January 1, 1964 to October 31, 2000) and 116 major earthquakes ($M_S \geq 7.0$) occurring in the mainland of China area (from 1895 to 2000). The estimated π values were closer to the true π with no more than 1.1% relative deviation for different temporal and spatial scales.

For the sake of comparison, we artificially generated 6 typical pseudorandom sequences, in which the number of each sequence is up to 10,000 in total. The first one is a Poissonian sequence distributed in the range of 1 to 500 (Davis, 1986). The others are constituted by the same Poissonian distribution along with 50%, 20%, 10%, 5%, and 1% periodic non-prime pairs, in which we simulated them by replacing every 2, 5, 10, 20, and 100 random numbers with an even number, respectively. The relative primality of every two integers was so decided for each sequence. The relative deviations of 6 estimated values to the true π were 0.2%, 37.0%, 7.1%, 4.9%, 2.2%, and 0.3%, respectively. Those simulating results could reasonably be used to quantitatively check the randomness of earthquakes with the π approach.

The integer pairs could be divided into 2 subsets. The integer pairs with common divisors apart from 1 accounted for $6/\pi^2$ of the whole pairs, while the rest without common divisors accounted for $1-6/\pi^2$. If the common divisors apart from 1 between any integer pair were considered to be the temporal or spatial interrelation among earthquakes that generated these integer pairs, the earthquakes with the temporal or spatial interrelation would statistically be $1-6/\pi^2$ of the whole dataset at most. The complexity of earthquakes is expressed by implicit randomness and characteristics of seismicity. In other words, if other physical precursors were not taken into account (e.g., Wu et al., 1976; Wakita et al., 1988), it might imply that two or more earthquakes were correlative with one another, or that an earthquake could be partly predictable on the basis of the event sequence itself, with ratio about 40% (i.e. $1-6/\pi^2$) at most.