

# Effective Integrated PI Algorithm and Its Applications to Automatic Processing of Space-Time Images in Seismic Activity

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The PI algorithm is a seismic physical statistical prediction models based on statistical mechanics of complex systems, which were raised by the seismic activity forecast studies and obtained rapid development in the applications (Rundle et al., 2000; Tiampo et al., 2002; Rundle et al., 2003; Nanjo et al., 2006; Chen et al., 2005; Jiang and Wu, 2008). A series of satisfactory prediction results have been made, however, after a detailed study on the PI method in seismic activity, we found:

(1) The general stability of earthquake statistics, the good and bad of the results for the PI method have a close relationship with the sensitivity of some parameters and the specific parameter settings of the PI algorithm. Therefore, the PI method and the other statistical methods have similar stability problems. Of course, the forward modeling method finding the optimal solutions of PI method by constantly trying to set the parameters has a certain amount of randomness, but also has some difficulty and challenging.

(2) While using the ROC icon scoring method (Rundle et al., 2000; Tiampo et al., 2002; Rundle et al., 2003; Nanjo et al., 2006; Chen et al., 2005; Jiang and Wu, 2008), including the separate two parts of the prospective rate and false rate, this is contrary to the customary understanding of quantitative score, and tend to score high, inconsistent with the actual situation. Of course, the definition of rules for seismic anomaly is one of the factors, but it is not the scope of this article.

For these above reasons, we will use the R value with quantitative score (Luo, 2004) to replace the ROC method with qualitative score, serves as the sole quantitative evaluation criteria of good and bad of PI predicted results, and on this basis, we also proposed multi-scale PSO (Kennedy and Eberhart, 1995) search strategy to realize the automatic optimization of optimal PI parameters. Through above technological transformation and integration for PI method, the new obtained PI model has some good with fast computation, global optimum and appropriate score. Accordingly, in order to analyze space-time evolution images of seismic activity and test the integrated the new model, we carried out the following work:

(1) We have studied the relative big strong seismic activity area in Yunnan and North China as testing examples, using the multi-scale PSO search algorithm to obtain the best parameters of PI method, and after based on the PI algorithms, the retrospective prediction tests of seismic activity in Yunnan region and North China since 1970 were carried out, and achieved remarkable results, raise a certain amount of prediction accuracy and the actual capacity.

(2) On the basis of above both regions, we also have calculated the three earthquake cases, including Yutian  $M_s7.3$ , Wenchuan  $M_s8.0$  and Yushu  $M_s7.1$  earthquake occurred Since 2008 in Western China, it is found that there were obvious anomalies of hotspot near the epicenter before these strong earthquakes.

Through the integration of PI method and analysis of practical seismic data, it is ultimately proved that the above improvement and integration of PI algorithm are reasonable and the practical application is feasible.