DETERMINATION OF CONCENTRATION OF EARTHQUAKES CLUSTERING

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Earthquakes arrive without previous warning and can destroy a whole city in a few seconds, causing numerous deaths and economical losses. Nowadays, a great effort is being made to develop techniques that forecast these unpredictable natural disasters by using statistical methods.

In most studies of earthquake spatial distribution prediction are used statistical estimation of the fractal spatial dimension (for example, Smith, 2003; Nelsen, 2006). Earthquake spatial distribution is very complex because of the depth inhomogeneity, the fractal character of spatial pattern, and various hypocenter location errors all make model parameterization difficult and create various biases in estimating parameters.

However, these publications insufficiently consider the systematic effects which influenced estimation of the fractal or scaling dimensions of earthquakes. Some of the above publications estimated several effects by using simulation catalogs; such simulations are insufficient for fully understanding various geometrical distributions.

In this paper, Copulas method is used for pattern recognition of earthquake distribution. The study of copulas and their applications in statistics is a rather modern phenomenon.

Copulas are of interest to statisticians for two main reasons: Firstly, as a way of studying scale-free measures of dependence; and secondly, as a starting point for statistical seismicity analysis with a view to simulation earthquake catalog.

The word copula was first employed in a mathematical or statistical sense by Machado and Santos Silva, (2005); Prokhorov and Schmidt (2006) in the theorem (which now bears his name) describing the functions that “join together” one-dimensional distribution functions to form multivariate distribution functions.

One of the primary applications of copulas is in simulation and Monte Carlo studies. In this paper, we used the problem of generating a sample from a specified joint distribution. Such samples can then be used to study mathematical models of earthquakes systems, or for statistical seismicity, such as the comparison of a new statistical method with competitors with small sample results.

Copulas model is applied on seismic temporal earthquake data catalog that can help to forecast medium and large earthquakes, Figure 1.

The Iranian seismic temporal data catalog is provided by the International Institute of Earthquake Engineering and Seismology (IIEES).

This statistical procedure is presented showing a remarkable performance and the significance of the obtained results in seismicity analysis. Copulas are also useful extensions and generalizations of approaches for modeling quantitative earthquake forecasting and its ability to predict the earthquake occurrence rate. In this paper the results of modeling and statistical analysis are applied to evaluate the short and long term occurrence rates of future earthquakes regionally, to test these forecast according to stringent criteria.

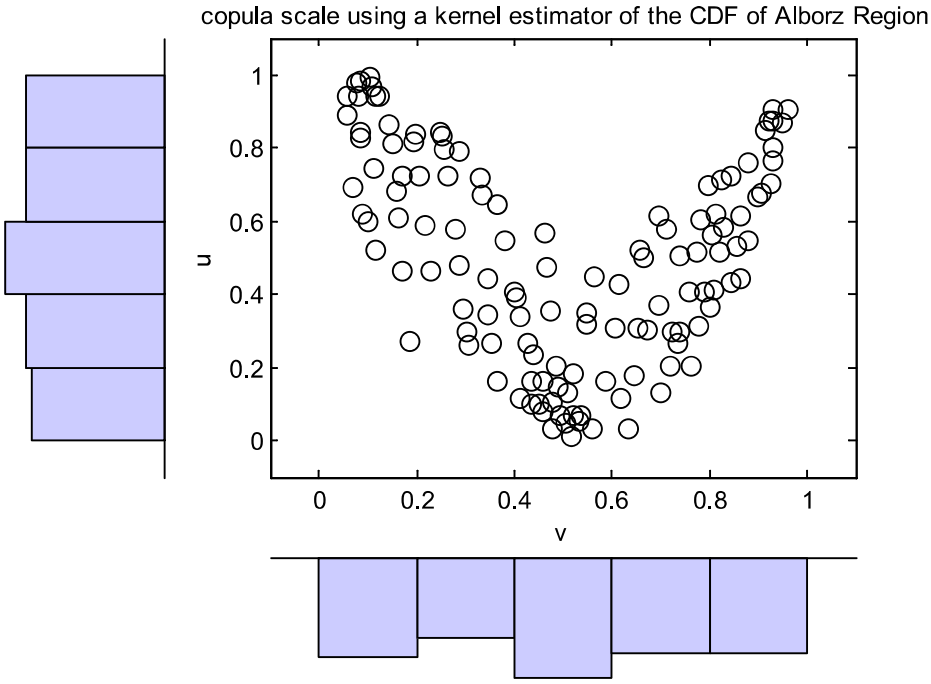

Figure 1. Simulated data catalog using Copula scale (by a Kernel estimator) of Alborz region for earthquake magnitude greater than 4.5 (local magnitude)

REFERENCES

Nelsen RB (2006) An Introduction to Copulas, 2nd edition, New York: Springer

Machado JAF and Santos Silva JMC (2005) Quantiles for counts, Journal of the American Statistical Association 100, 1226–1237

Prokhorov A and Schmidt P (2006) Robustness, redundancy, and validity of copulas in likelihood models, Working Paper, Michigan State University

Smith M (2003) Modeling selectivity using archimedean copulas, Econometrics Journal, 6, 99–123