HIGH PERFORMANCE COMPUTING FOR ESTIMATION, PREDICTION AND FORECASTING IN EARTH SCIENCES

Asad Habib[1], Muhammad Ali[2]

[1]*Institute of Information Technology Kohat University of Science and Technology Kohat, Pakistan*

[2]*National Centre of Excellence in Geology, University of Peshawar, Pakistan*

asadhabib@kust.edu.pk

Abstract

We are living in an uncertain world where the Earth is prone to various natural and human induced hazards at all spatial scales, ranging from local to global. Mitigation of the hazards along with sustainable utilization of various natural and man-made resources is the call of the day for better and safe future. However, integration, compatibility and processing of large volume of complex data is a real challenge for relevant community. High Performance Computing methods assist in timely and reliable predictions/estimation of various variables and state-variables with respect to space and time (spatio-temporal) in Earth and environmental sciences. Also, it will lead to sustainable utilization, improved planning and management system of various natural and man-made resources for future generations.

The satellite remote sensing systems produce enormous amount of periodic as well as sporadic spatio-temporal multimedia data. Compression of this big-data by identification and removal of redundant and nearly redundant data offer a knotty challenge to manipulate this big-data in real-time. Consequently, it can be very expensive both in terms of computational and human resources. Some GPS transceivers produce and accumulate data every few seconds that may produce huge amount of multimedia data in a very short period of time. Trajectory data is a sequence of temporally ordered GPS coordinates. According to statistics released by the department of transportation of United States, 53 Tera-Bytes of GPS data was produced in 2011 [1]. Consequently, this multimedia big-data will require high performance computing for various functions such as visualization and mining patterns etc.

The availability of big-data multimedia datasets and compatibility of high performance computing systems with satellite based remote sensing systems using advanced computer simulation models are opening new horizons for research in a number of inter-related domains such as optimized utilization of natural and man-made Earth resources, trajectory patterns mining, urban planning and spatio-temporal predictions/estimation and forecasting.

Sophisticated state of the art statistical and geo-statistical techniques (including; spatio-temporal interpolation and extrapolation, data assimilation methods, model simulations approaches) are extensively employed to make precise predictions for spatio-temporal patterns and trends. Contemporary computing technologies and simulation models are extensively arrayed to predict spatio-temporal patterns at all spatial scales (single point to global) of various land surface processes such as soil moisture, runoff, precipitation, evapotranspiration, seismicity, agriculture practices, water management and many other relevant disciplines. On the contrary, these spatio-temporal prediction models suffer some shortcomings, for instance, redundancy and inconsistency in datasets and extra ordinarily high cost of computing as well as human resources.

References

[1] Y. Han, W. Sun, and B. Zheng. Compress: A comprehensive framework of trajectory compression in road networks. ACM Trans. Database Syst., 42(2):11:1–11:49, May 2017.