Cumulative Viewshed Analysis using GRID Computing

(abstract of proposed paper for Geocomputation 2007)

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1. Introduction

Geographic Information Systems (GIS) are increasingly being used as tools to generate information for environmental planning policy and decision making. Data analysis, accuracy and repeatability are important to guarantee that properly informed decisions are made. The data and analysis results need to be shared amongst multiple parties, and the integrity of the datasets need to be maintained.

Previous work has revealed that certain computationally expensive areas of GIS such as viewshed analysis are especially problematic. Studies of viewshed analysis have shown that data resolution and minor data errors contribute to inconsistency in the analysis. The repeatability of the results is made difficult because of the length of time taken to perform the calculations. Furthermore, algorithm differences amongst various GIS packages lead to variations in the results.

Our work combines the emerging field of grid computing with open-source GIS to improve the calculation time of viewshed analysis. This allows a finer resolution of data to be used, and for calculations to be re-run with different parameters. Our tools provide a platform that maintains data integrity and allows open inspection and review of algorithms.

2. Viewshed Calculation Problems

Viewshed analysis is a GIS operation used to determine all visible areas from a given location. It is used extensively for planning decisions and policy making. Riggs and Dean (2007) report that P. F. Fisher raised concerns about viewshed analysis reliability in 1991. They surveyed a variety of GIS packages and found that the problems of inaccuracy and inconsistency remain. Their findings show that the main problems are due to data errors, data resolution and viewshed analysis algorithm errors.

Much viewshed analysis is undertaken at a coarse resolution as a result of the time it takes to perform the calculations. A decrease in calculation time allows a finer resolution of data to be used. Errors in algorithms are a key issue with most software packages, especially where the algorithms are not published or open to inspection. Input data errors are more difficult to deal with as little can be done about poor quality input data arising from survey inaccuracy or from the data-gathering techniques.

3. Grid and High-Throughput Computing

Our research uses grid computing with open source GIS software to address these issues. Grid computing facilitates resource sharing and problem solving in dynamic, multi-

institutional virtual organizations. Virtual organizations are composed of sets of people from various real institutions that benefit from collaborating and sharing their computation and data processing environments. We combine a grid computing environment with tools for High-Throughput Computing (HTC).

We use the Globus Toolkit (GT4) to provide the grid services. GT4 is an open source software toolkit developed by the Globus Alliance. The toolkit is a collection of components for information infrastructure, resource and data management, and secure communication. Grids can make use of high-throughput computing tools to reduce the time it takes to conduct computationally intensive problems. HTC tools take advantage of unused resources such as CPU cycles and disk storage of large numbers of computers in a distributed communications infrastructure. For our project we are making use of the Condor batch system (http://www.cs.wisc.edu/condor).

Llobera *et. al*. (2004) developed an approach that used the Condor HTC system to distribute viewshed calculations across 43 workstations. They performed their test calculations in 25 hours instead of the 34 days they estimated a non-distributed solution would take. In the article, they describe using their own implementation of a well-known viewshed calculation algorithm. Their results are very promising; we hope to achieve similar savings in time. However, their solution was limited to their own algorithm implementation and did not use a grid solution. Our open-source approach makes our algorithms fully available for inspection, review and even verification. Our grid-based approach exploits many useful features of grid computing such as resource sharing across organizations, data abstraction, security, and job scheduling.

4. Open-Source GIS Tools

Riggs and Dean (2007) point out that the algorithms used to conduct the analysis can introduce errors. Errors can arise from issues with the lines of sight and with the identification of obstructions to them. Commercial packages do not tend to publish the algorithms they use. Open-source GIS packages, on the other hand, expose the algorithms to review and modification. Using open-source viewshed analysis tools can therefore increase the accuracy and dependability of the system. We have chosen to use the Geographic Resources Analysis Support System (GRASS).

Acknowledgements

The authors gratefully acknowledge the support of their colleagues at the University of Stirling in the Department of Computing Science and Mathematics, and in the School of Biological and Environmental Science.

References

P. D. Riggs and D. J. Dean. An Investigation into the Causes of Errors and Inconsistencies in Predicted Viewsheds, *Transactions in GI*S, 11(2):175–196, 2007.

M. Llobera, D. W. Wheatley, T. J. M. Steele, S. Cox and O. Parchment. Calculating the inherent visual structure of a landscape (‘total viewshed’) using high-throughput computing, in, *Proc. XXXII International Conference on Computer Applications in Archaeology,* Prato, Italy, April 2004.