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A Parallel Method for Accelerating Visualization for Vector Tiles

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Abstract:

Vector tile technology is developing rapidly and has received increasing attention in recent years. Compared to the raster tile, the vector tile has shown incomparable advantages, such as flexible map styles, suitability for high-resolution screens and ease of interaction. Recent studies on vector tiles have mostly focused on improving the efficiency on the server side and have overlooked the efficiency on the client side, which would actually affect user experience. Parallel computing provides solutions to this issue. Parallel visualization for vector tiles is a typical example of embarrassing parallelism, because there is no need for communications between computing units during parallel computing. Therefore, the performance of parallel visualization for vector tiles mainly depends on how the workload is accurately estimated and evenly decomposed onto the computing units.

The estimation of workload of vector tile visualization is essentially an accurate estimation of the computing time of geographical feature visualization in the tile. This article uses the computational weight to represent the computing time of geographical feature visualization. The visualization process for geographical feature consists of three main steps: retrieving geographical feature, symbolizing geographical feature and rendering geographical feature. This article analysis the influential factors and building the computational weight functions (CWFs) of different types of geographical feature (point, linear and area) in different visualization steps. Then, by analysing the linear relationship between the influential factors and the computing time of geographical feature visualization, the coefficients of CWFs can be obtained by linear regressions. The goodness of fit of all the linear regressions are significant ($R^2 > 0.9$), which means the computing time of geographical feature visualization, can be accurately estimated by CWFs.

Once the computational weight of vector tiles is calculated, the workload decomposition is the next key issue. The traditional decomposition methods widely used in spatial domain decomposition are based on evenly divided spatial areas, such as vertical decomposition, horizontal decomposition and so on. However, the distribution of geographical features are usually uneven, the traditional decomposition methods may introduce large imbalance of workload for parallel computing and degrade the efficiency and performance. This article proposes a workload decomposition method based on the computational weight of vector tiles to improve the parallel visualization efficiency of vector tiles. Experiments show that the computational efficiency of parallel visualization of vector tiles with the proposed workload decomposition method is 18.6% higher than that with traditional decomposition methods.

Keywords: vector tile, geographical feature visualization, parallel computing, computational weight, workload decomposition.

