Balanced Aspect Ratio Trees and Their Use for Drawing Very Large Graphs

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Abstract

We describe a new approach for cluster-based drawing of very large graphs, which obtains clusters by using binary space partition (BSP) trees. We also introduce a novel BSP-type decomposition, called the *balanced aspect ratio* (BAR) tree, which has a number of interesting properties. The BAR tree guarantees that the cells produced are convex and have bounded aspect ratios. In addition, the tree depth is $O(\log n)$, and its construction takes $O(n \log n)$ time, where n is the number of points. We show that the BAR tree can be used to recursively divide a graph into subgraphs of roughly equal size, such that the drawing of each subgraph has a *balanced aspect ratio*. As a result, we obtain a representation of a graph as a collection of $O(\log n)$ layers, where each succeeding layer represents the graph in an increasing level of detail. The algorithm does not rely on any specific properties of the graph, other than its ability to be initially embedded (so that we can then apply our BSP clustering technique). The overall running time of the algorithm is $O(n \log n + m + D_0(G))$, where n and m are the number of vertices and edges of the graph G, and $D_0(G)$ is the time it takes to obtain an initial embedding of G. In particular, if the graph is planar each layer is a graph drawn with straight lines and without crossings on the $n \times n$ grid and the running time reduces to $O(n \log n)$.

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