

Browsing large graphs with MSAGLJS, a graph dragh drawing tool in JavaScript

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Msagljs github home page: <https://github.com/microsoft/msagljs>

Abstract. There has been progress in visualization of large graphs recently. Still, interacting with a large graph in the browser with the same ease as browsing an online map, inspecting the high level structure and zooming to the lower details, is still an unsolved problem, in our opinion. In this paper we describe MSAGLJS's approach to two aspects of this problem. Firstly, we give a novel algorithm for edge routing, where the edges do not overlap the nodes. The algorithm does not necessarily create optimal paths but is efficient and creates visually appealing paths. Secondly, to facilitate graph vizualization with DeckGL, namely fast zoom, and pan operations, and keeping the number of entities on the screen below a specific bound all the time, we use tiling. Our tiling procedure is simple and efficient. It is the second contribution of the paper.

1 Introduction

2 Related work

3 Links to large graph visualization

4 [1]

5 [2]

6 [3]

7 [4]

8 [5]

9 [6]

10 machine learing approach [7]

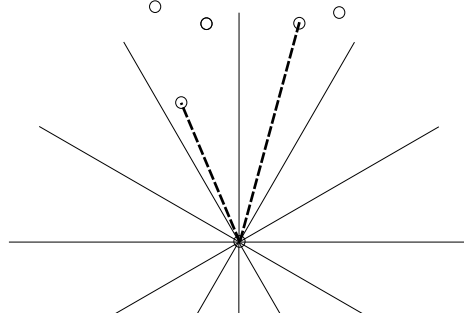
11 [8]

12 [9]

13 Edge routing

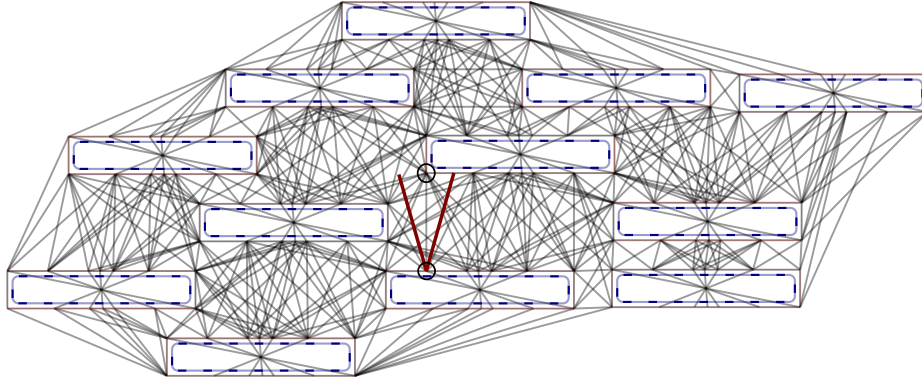
14 The edge routing starts, as in [10], by building a spanner graph, an approximation
15 of the full visibility graph. The spanner, see Fig. 2, is built on a variation of a

16 Yao graph, which was introduced independently by Flinchbaugh and Jones [11]
 17 and Yao [12]. A Yao graph is defined by the set of cones with the apices at
 18 the vertices. The cones have the same angle, usually in the form of $\frac{2\pi}{n}$, where
 19 n is a natural number. This way the cones with the apex at a specific vertex
 20 partition the plane as illustrated in Fig. 1. For each cone at most one edge is
 21 created connecting the cone apex with a vertex inside of the cone.



22

Fig. 1. Fragment of a Yao graph



23 **Fig. 2.** Spanner graph is built using the idea of Yao graphs. The dashed curves are the
 24 original node boundaries. Each original curve is surrounded by a polygon with some
 25 offset to allow the polyline paths smoothing without intersecting the former.
 26 The edge marked by the circles is created because the top vertex is inside of the cone
 27 and it is the closest among such vertices to the cone apex. The apex of the cone is the
 28 lower vertex of the edge.
 29 MSAGLJS uses cone angle $\frac{\pi}{6}$. This gives a path of length that is not greater than the
 30 shortest length divided by $\cos(\frac{\pi}{12}) \simeq 0.9659$.

34 The approach of [10] first builds a polyline path through the spanner, and
 35 then applies some local modifications to shorten and smoothen the path. For
 36 shortening it tries to shortcut a vertex, as illustrated in Fig 3. To smoothen it
 37 fits Bezier segment into the polyline corners, using the binary search to find the

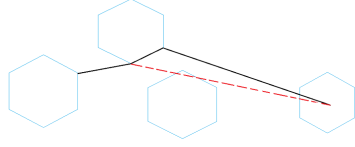


Fig. 3. Unsuccessful shortcut

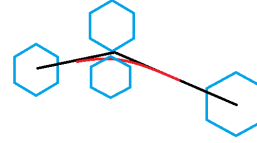


Fig. 4. Fitting a Bezier segment into a polyline corner

larger fitting segments, see Fig 4. While analyzing performance of edge routing in MSAGLJS, we noticed that for a graph with more than 10000 edges these heuristics become the major bottleneck.

The reason for this was that we queried if a curve intersects any node of the whole graph. In spite of optimizing these operations with R-Trees [13], about %90 of the edge routing running time was spent on them. In addition, when the naive shortcutting of polyline corners fails the resulting path is not visually appealing, as shown in Fig. 3.

References

1. “Graphexp.” <https://github.com/bricaud/graphexp>.
2. “Graphviz.” <http://www.graphviz.org/>.
3. “Regraph.” <https://cambridge-intelligence.com/regraph/>.
4. “Skewed.” <https://graph-tool.skewed.de>.
5. “Circos.” <http://circos.ca/>.
6. H. Gibson, J. Faith, and P. Vickers, “A survey of two-dimensional graph layout techniques for information visualisation,” *Information visualization*, vol. 12, no. 3-4, pp. 324–357, 2013.
7. O.-H. Kwon, T. Crnovrsanin, and K.-L. Ma, “What would a graph look like in this layout? a machine learning approach to large graph visualization,” *IEEE transactions on visualization and computer graphics*, vol. 24, no. 1, pp. 478–488, 2017.
8. Z. Lin, N. Cao, H. Tong, F. Wang, U. Kang, and D. H. Chau, “Interactive multi-resolution exploration of million node graphs,” in *IEEE VIS*, 2013.
9. “Cosmograph.” <https://cosmograph.app>.
10. T. Dwyer and L. Nachmanson, “Fast edge-routing for large graphs,” in *Graph Drawing: 17th International Symposium, GD 2009, Chicago, IL, USA, September 22-25, 2009. Revised Papers 17*, pp. 147–158, Springer, 2010.
11. B. Flinchbaugh and L. Jones, “Strong connectivity in directional nearest-neighbor graphs,” *SIAM Journal on Algebraic Discrete Methods*, vol. 2, no. 4, pp. 461–463, 1981.
12. A. C.-C. Yao, “On constructing minimum spanning trees in k-dimensional spaces and related problems,” *SIAM Journal on Computing*, vol. 11, no. 4, pp. 721–736, 1982.
13. A. Guttman, “R-trees: A dynamic index structure for spatial searching,” in *Proceedings of the 1984 ACM SIGMOD international conference on Management of data*, pp. 47–57, 1984.