Effective Geometry of Urban Road Networks

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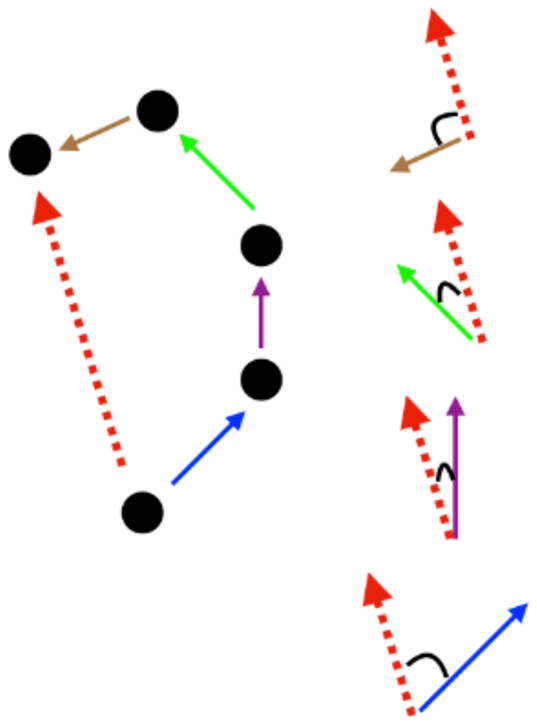
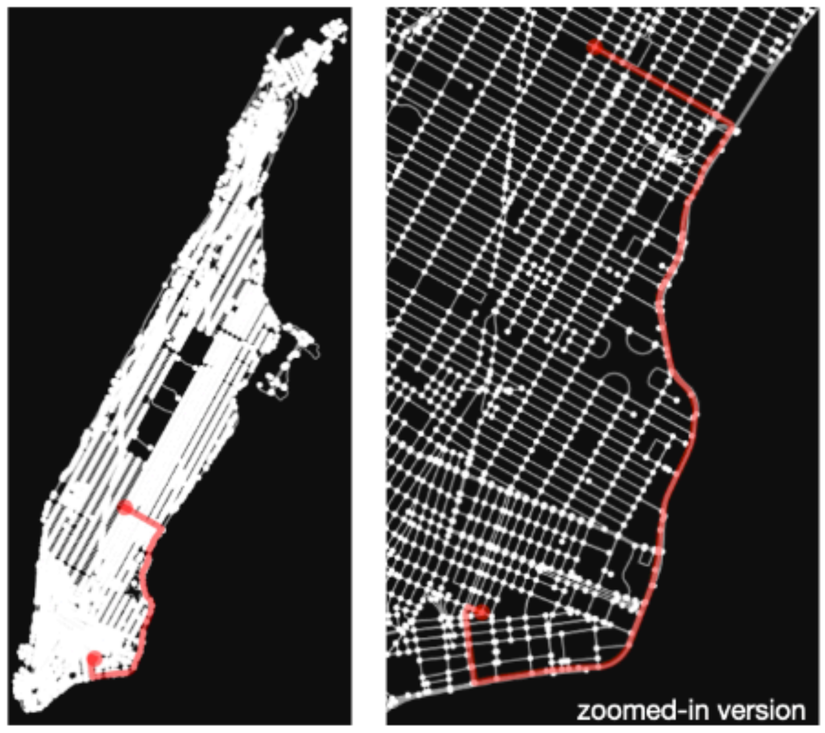
Introduction

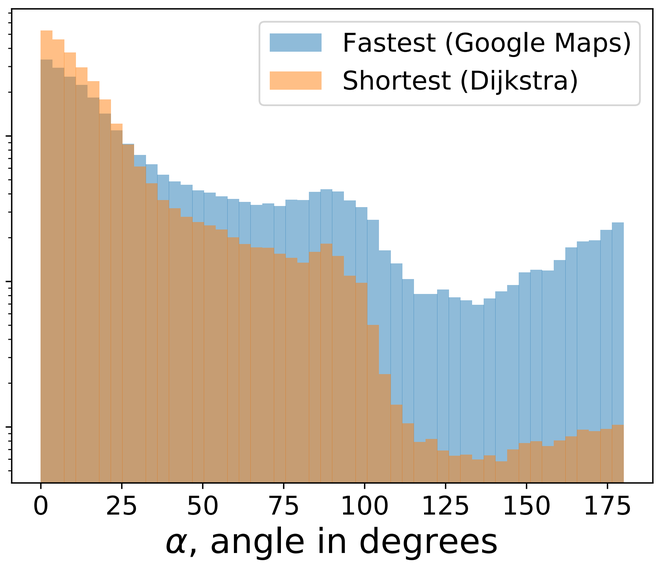
- The structure of **road networks** play an important role in determining traffic flows, especially in cities. Using data on the geometrical properties of these networks and tools from Riemannian geometry, we seek to infer a metric which can inform us of the network's behavior and characterize its flows.
- One such geometrical property we study is the shape of the **fastest driving routes** to and from various points in the city. This can be assessed in multiple ways; in this project, we measure the **angles** between the vector connecting the source and target node and the vectors connecting each pair of consecutive nodes in the path.





Google Maps vs. Dijkstra

- Google Maps gives the **fastest** route between a source and target node in a network, whereas Dijkstra's Method gives the **shortest** route.
- To understand how the fastest (Google Maps) and shortest (Dijkstra) routes from source to target node differ, we analyze the distribution of all angles (calculated as described above) obtained from both the Google Maps and Dijkstra routes connecting 23 variously chosen source nodes to all other possible target nodes in Manhattan (~100,000 different pairs of source and target nodes).
- As expected, the **fastest** routes were more likely to have **larger angles** than the shortest routes, indicating that the fastest routes violated the underlying Euclidean geometry, probably due to attractors in the network such as highways. The fastest routes were also **longer** and had **larger maximum and average angles** than the shortest.



Highways

- We also examine the angle distributions of Google Maps (fastest) routes that do and do not use highways.
- Routes which use **highways** were likelier to have **larger angles**, again supporting our hypothesis that highways are attractors in the network. These routes also corresponded to **larger distances** between the source and target node.