Using Time Cartograms for the Visual Representation of Free Movement Data

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A great amount of multivariable temporal data is available these days. Temporal data are often related to movement. This could be along fixed networks, such as rail or road networks, or free movement by animals or birds. Suitable visual representations need to be designed in order to analyze and synthesize these data to produce useful insights about phenomena and systems represented by the data [2].

Modern computer technologies make it possible to use alternative visualization methods. A time cartogram is an alternative visual tool, which is well-suited for representing temporal data related to movement along paths with stops. It visualizes travelling-times by replacing geographic-distance with time-distance, distorting the geography accordingly. Two types of time cartograms exist: centered and non-centered. A centered time cartograms shows travelling-times from a starting location to all other destinations in the region, while a non-centered time cartogram visualizes travelling-times between all pairs of locations.

In the literature, we find some examples of time cartograms applied mainly to network based movement (e.g., [1] [3]). However, limited research has been done on time cartograms to represent temporal data associated with free movement. Hence, there are challenges to develop new algorithms and to create time cartograms for both the network based and especially free movement.

In our previous work [4], a two-step method to constructing centered time cartograms for the visual representation of scheduled movement data was presented. A case of the Dutch railways was used to illustrate the method. The method involved vector calculus (to displace the train station based on travelling-times from a starting station) and moving-lease-squares based affine deformation (to deform the map's boundaries and the railroads accordingly). An example output is given in Fig. 1. Fig. 1a shows the Dutch railways network in the province of Overijssel. Travelling-times (in minutes) between stations are indicted by numbers along the railroad segments. Fig. 1b is a centered time cartogram with Enschede as the starting station. This particular cartogram shows travelling-times (indicated by the concentric circles) from the city of Enschede to other parts of the Overijssel.

In this research, a two-step method to construct non-centered time cartograms for the visual representation of free movement data is proposed (see Fig. 2). The first step uses vector calculus to distort the locations based on travelling-times between them. The second step applies moving-least-squares based similarity deformation to distort the background accordingly. The mathematical detail of the method and the results will be presented during the workshop.

References

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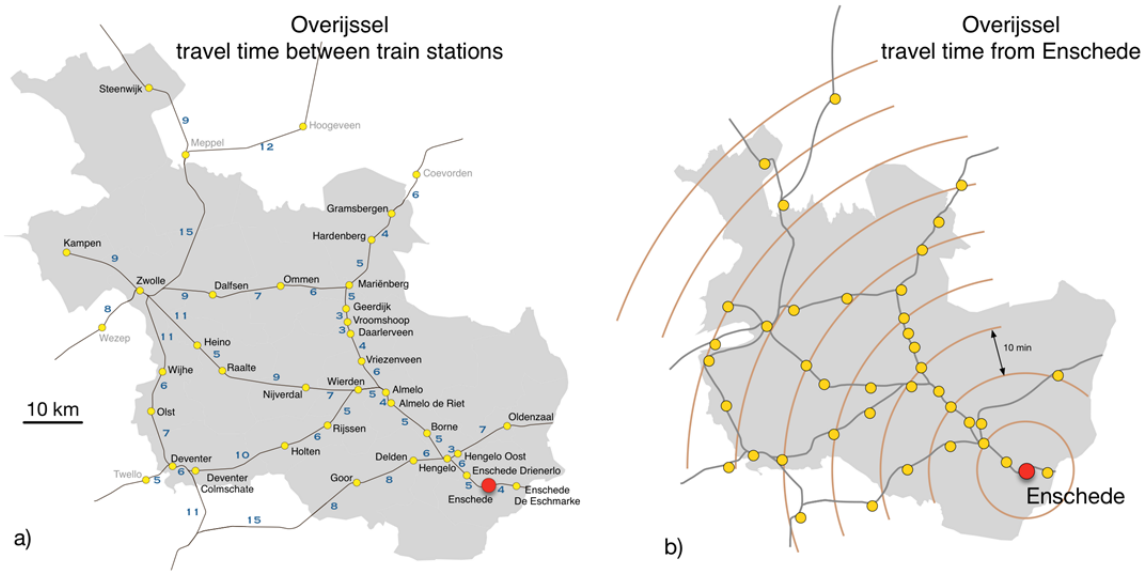

Fig. 1. a): Overijssel's railways. b): A centered time cartogram with the city of Enschede as the starting station. The concentric circles depict the travelling-times in steps of 10 minutes from the starting station.

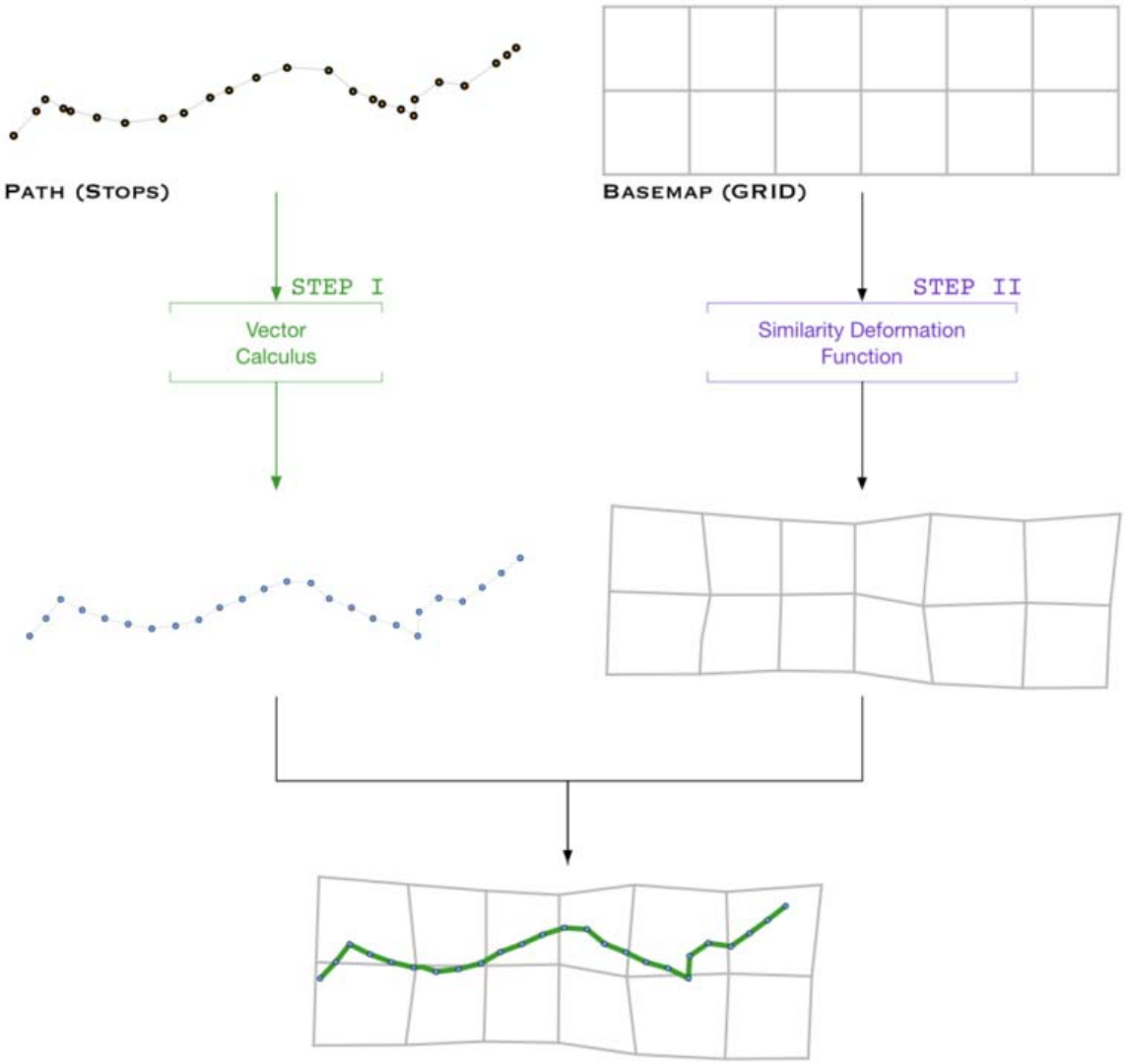

Fig. 2. The proposed two-step method for the construction of non-centered time cartograms. The method involves vector calculus and moving-least-squares based similarity deformation. The vector calculus is used to distort the locations based on travelling-times, and the moving-least-squares based similarity deformation is applied to distort the background accordingly.