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Transfer learning with a spatiotemporal graph convolution network for city flow prediction

Key words: Transfer learning; City flow prediction; Spatiotemporal graph convolution

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Motivation

Previous studies on transfer learning prediction of city flow usually employ the parameter sharing scheme. The source and target domain cities are usually split into grids or subgraphs of the same size, which makes it difficult to express the natural non-Euclidean geometrical features of city flows and thus reduces the prediction accuracy.

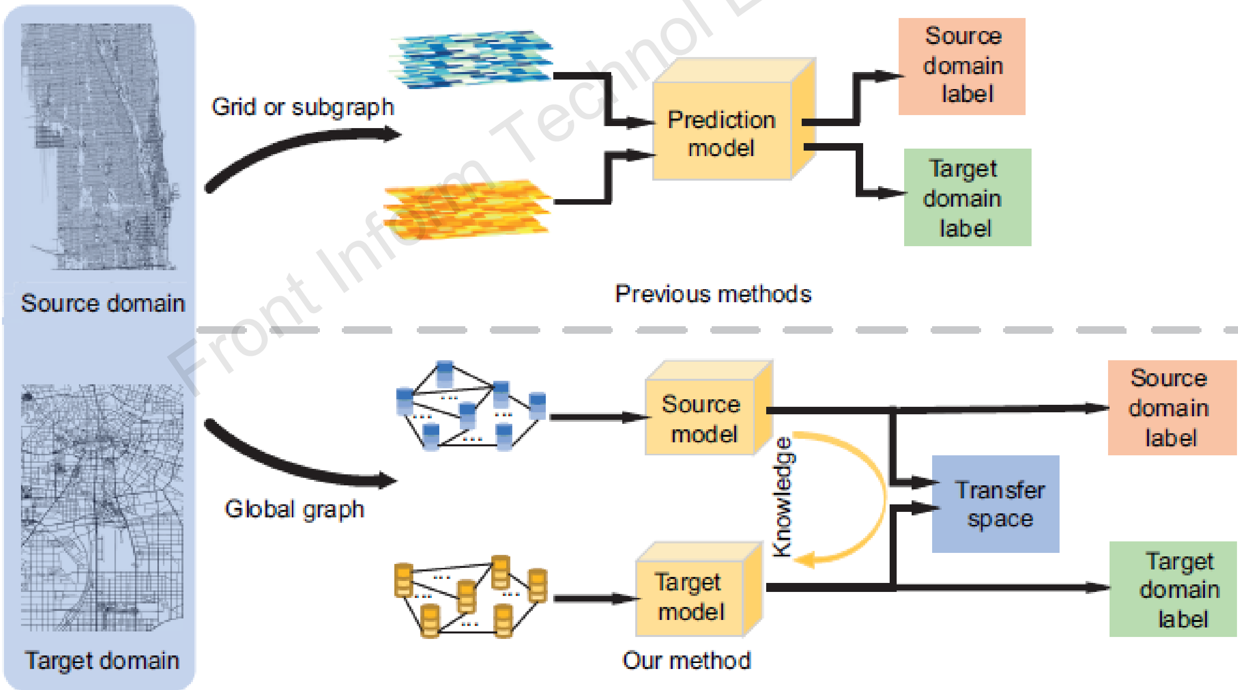
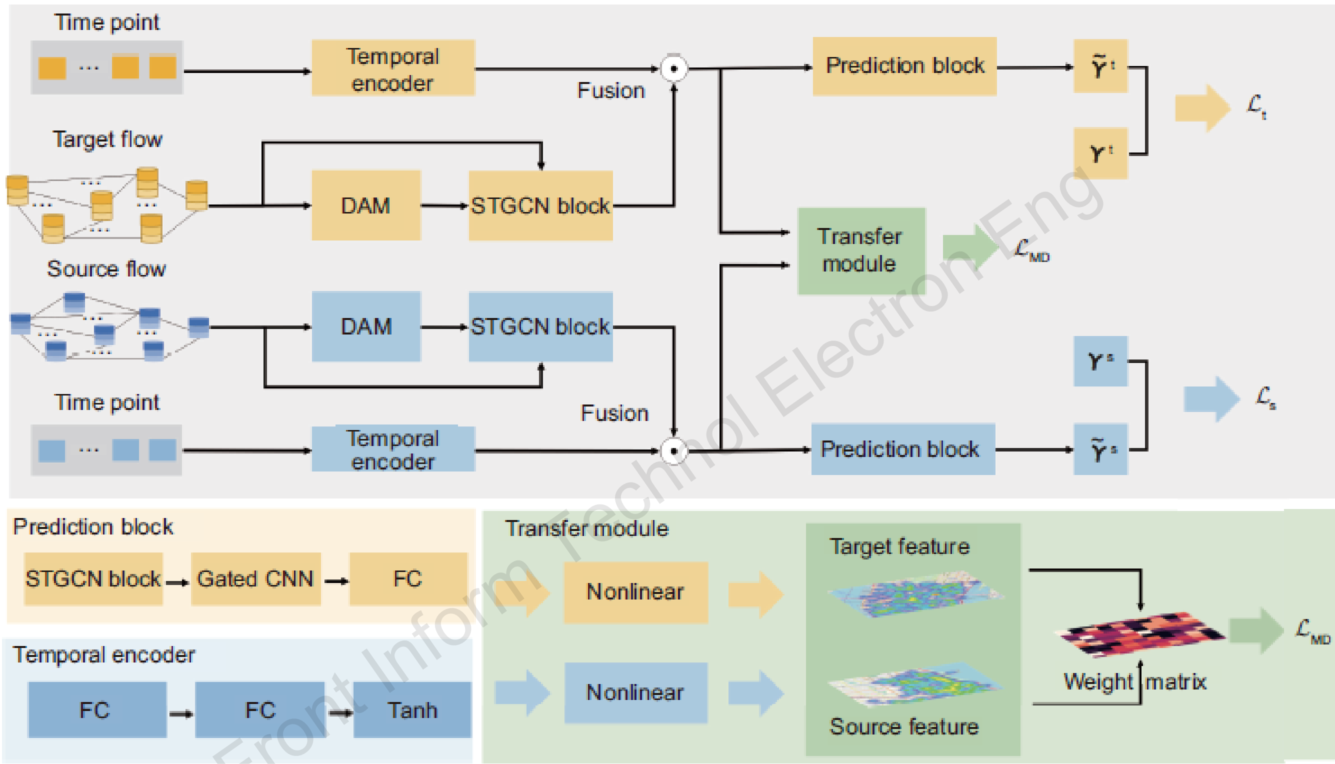


Fig. 1 Different transfer prediction strategies

Main idea

- To address the difficulty that there are differences in the structures of road networks in different cities, we propose a transfer learning method based on spatiotemporal graph convolution network (TL-STGCN).
- Considering that city flows are related to road networks and human travel habits, we design a dynamic spatiotemporal graph convolution module and a spatiotemporal encoder to explore cross-city invariant representations.

Method



Dynamic adjacency matrix (DAM) explores the similarity of spatial structures and improves the adaptation of global spatial dependency information.

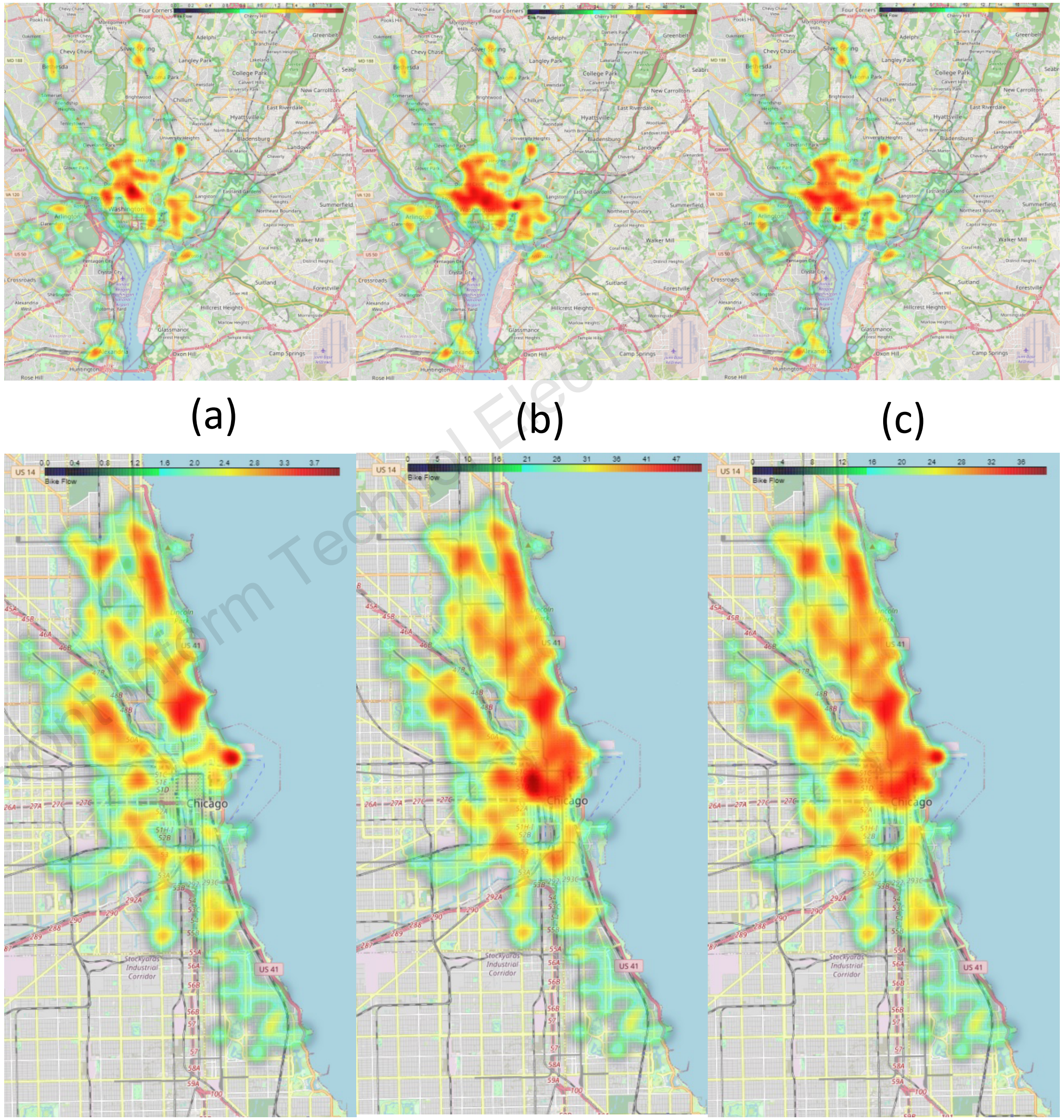
Temporal encoder encodes the time points to obtain the effect of time points on the city flow.

Transfer learning loss can be described as

$$\mathcal{L}_{\mathrm{MD}} = \frac{1}{NT} \sum_{n=1}^{N} \sum_{t=1}^{T} \sum_{c=1}^{C} \left(\boldsymbol{H}^{\mathrm{s}}_{n,t,c} - \boldsymbol{H}^{\mathrm{t}}_{n,t,c} \right) \cdot \boldsymbol{M}' \left(\boldsymbol{H}^{\mathrm{s}}_{n,t,c} - \boldsymbol{H}^{\mathrm{t}}_{n,t,c} \right)^{\mathrm{T}},$$

Results

Heatmap of bike flow prediction in a day from Chicago to Washington at 0:00 a.m. (a), 8:00 a.m. (b), 12:00 a.m. (c), from Washington to Chicago at 0:00 a.m. (d), 8:00 a.m. (e), 12:00 a.m. (f)



(a) (b) (c)

(d) (e) (f)

Conclusions

We propose TL-STGCN that can use data-rich source domains to help data-poor target domains improve the prediction performance. We project the spatiotemporal data of the source and target domains into a common feature space through nonlinear mapping, minimize the distribution difference between the source and target domains, and achieve knowledge transfer from the source domain to the target domain. Finally, we conduct experiments with real bike flow data from Chicago, New York, and Washington. Experimental results show that our proposed method is better than baselines. In the future, we will extend TL-STGCN to other spatiotemporal transfer prediction problems, such as exhaust gas prediction, air quality index prediction, and people flow prediction.

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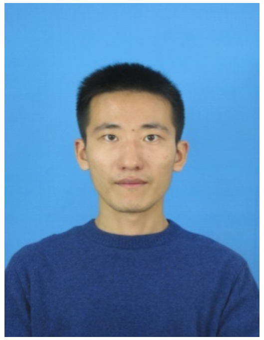

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