基于生成对抗网络的城市路网交通状态估计

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概要

一、汇报人基本信息

二、前期研究

1. 基于生成对抗网络的行程时间估计
2. 基于生成对抗网络的交通数据补全
3. 基于生成对抗网络的交通状态重构
4. 基于多任务学习的短时交通状态预测
5. 近年来发表论文

1、基于生成对抗网络的行程时间估计

问题描述：利用历史轨迹数据估计任意给定起止位置的行程时间

采用方法：

1. 模型框架：行程信息最大化生成对抗网络（Trip Information Maximizing Generative Adversarial Network (T-InfoGAN)）

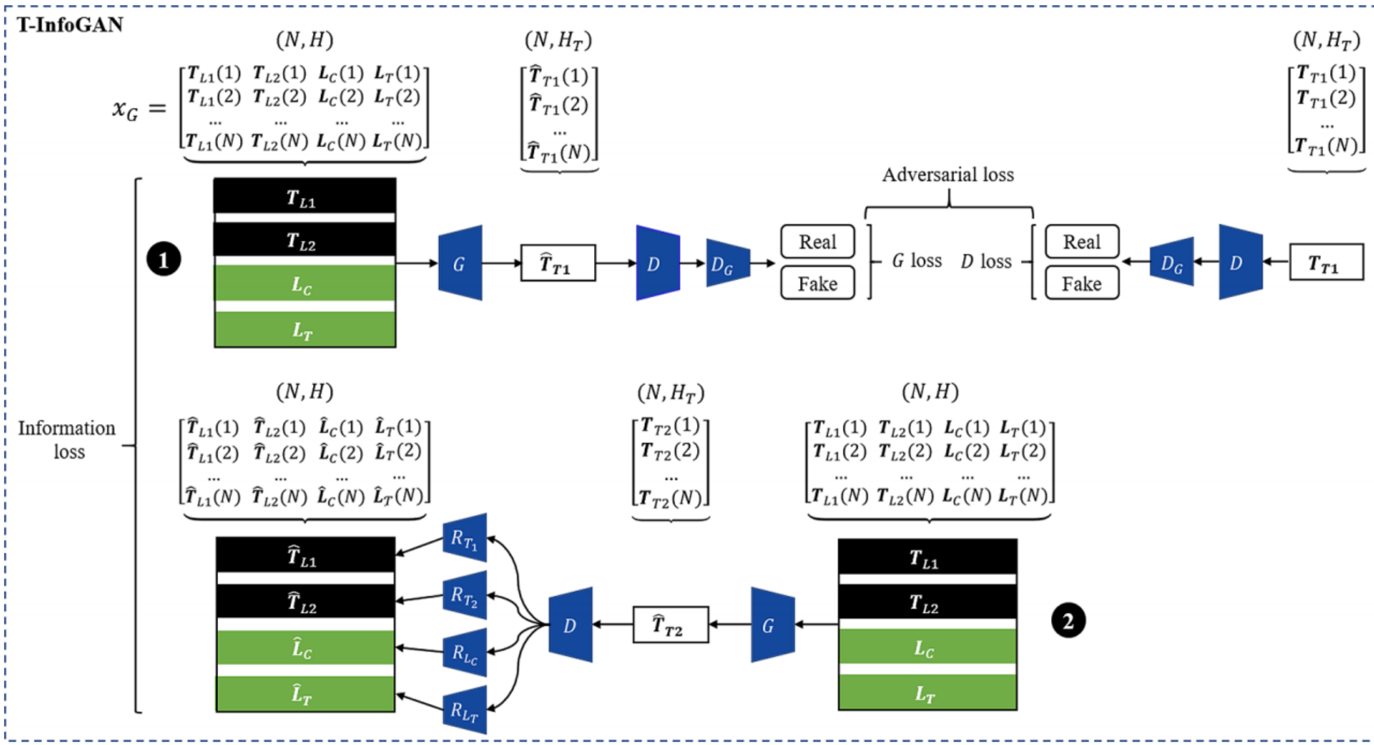


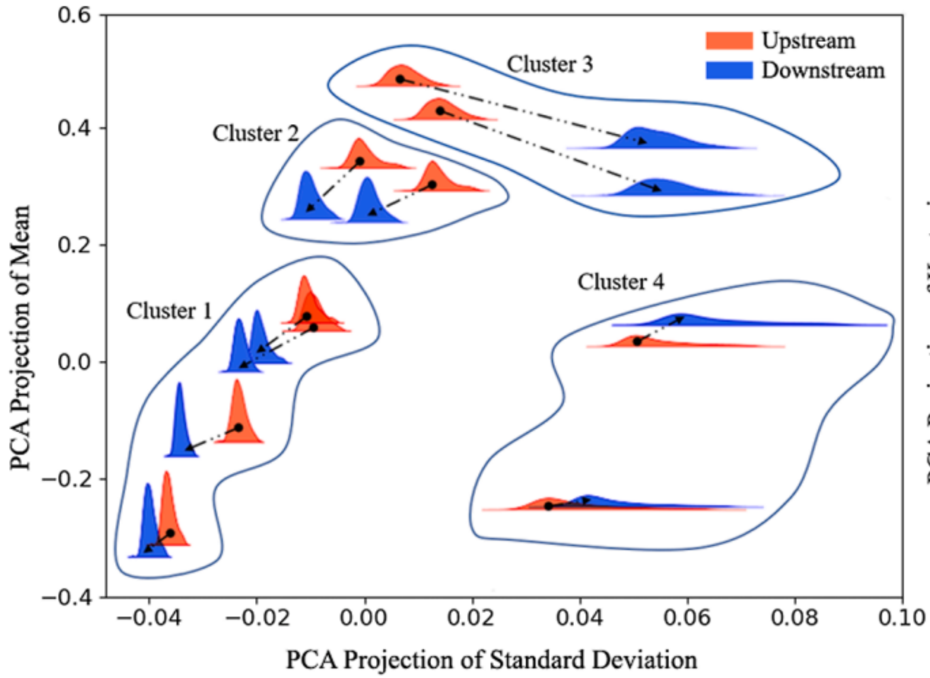
图1 行程信息最大化生成对抗网络模型的内部结构

Kunpeng Zhang, Ning Jia, Zijian Liu, Liang Zheng*. (2019) A novel generative adversarial network for estimation of trip travel time distribution with trajectory data. *Transportation Research Part C: Emerging Technologies*, 108, 223-244.

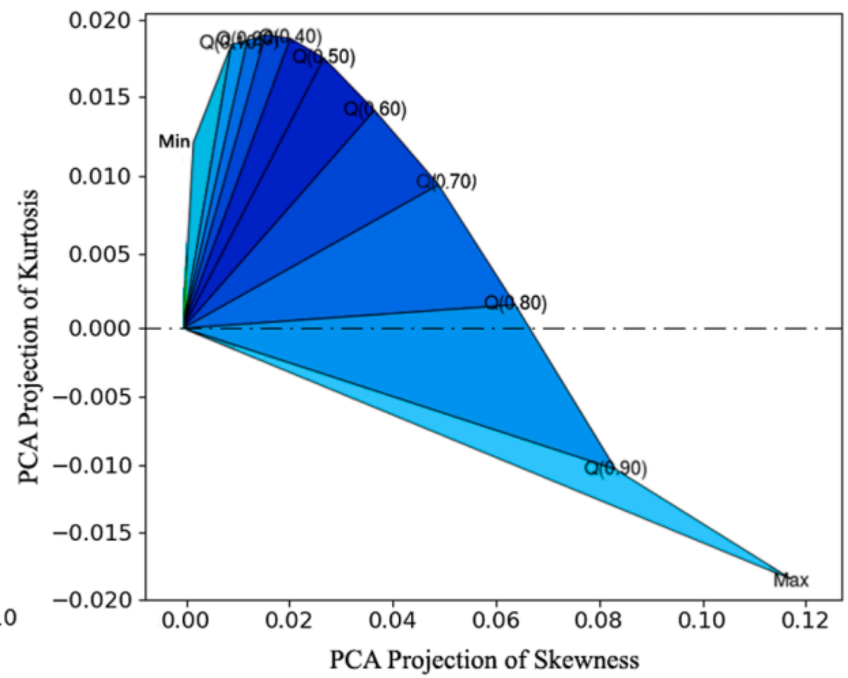
1、基于生成对抗网络的行程时间估计

采用方法：

2. 交通状态聚类分析： Dynamic Clustering with Wasserstein Distance (DCWD) Algorithm



(a) Distribution cluster



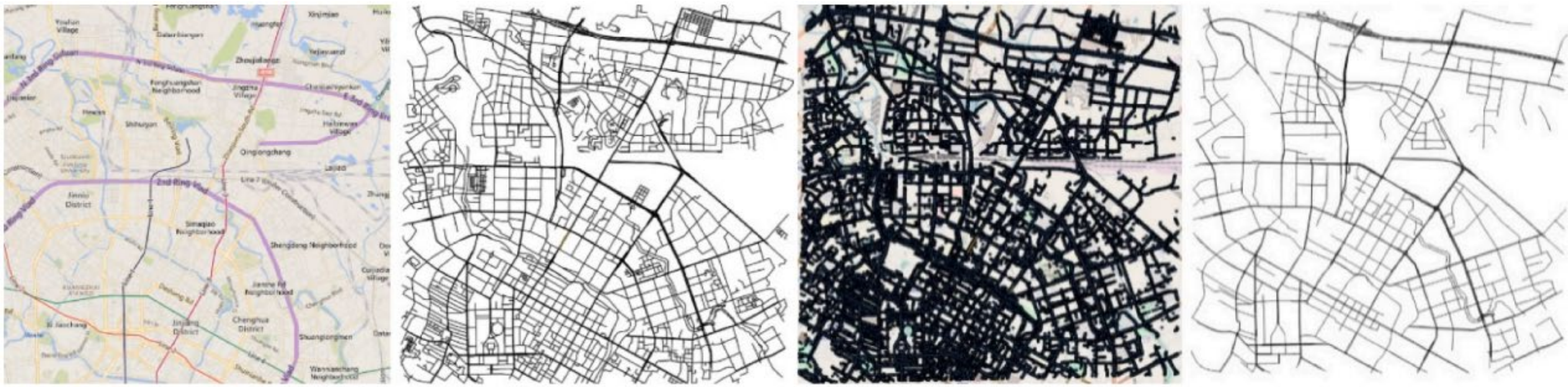
(b) Spanish-fan plot of the quantile-variables

图2 交通状态聚类结果示例

Kunpeng Zhang, Ning Jia, Zijian Liu, Liang Zheng*. (2019) A novel generative adversarial network for estimation of trip travel time distribution with trajectory data. *Transportation Research Part C: Emerging Technologies*, 108, 223-244.

1、基于生成对抗网络的行程时间估计

研究区域：成都



(a) Study site (b) Road network (c) GPS trajectories (d) Study links

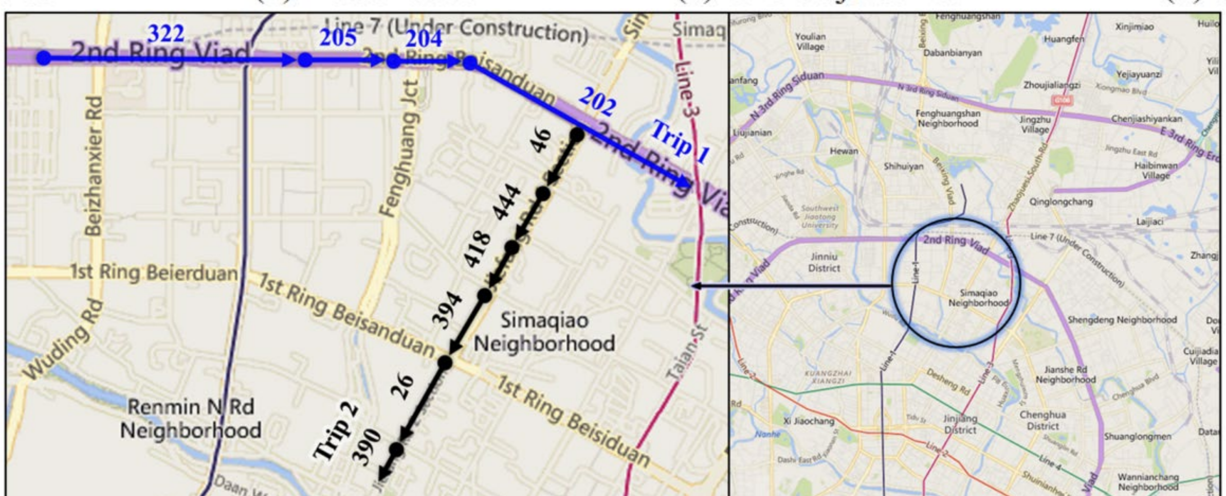


图3 研究区域

Kunpeng Zhang, Ning Jia, Zijian Liu, Liang Zheng*. (2019) A novel generative adversarial network for estimation of trip travel time distribution with trajectory data. *Transportation Research Part C: Emerging Technologies*, 108, 223-244.

1、基于生成对抗网络的行程时间估计

模型比较：

表1 模型预测结果

Trip	Time interval	Method	ℓ_1WD	KS test	Mean	Std	Skewness	Kurtosis
1	8:00–8:30	Observed	0.000	1	203.271 (0.00)	14.141 (0.00)	2.128 (0.00)	9.862 (0.00)
		Convolution	0.085	0	208.078 (4.81)	22.334 (8.19)	1.080 (1.05)	3.288 (6.57)
		MC-Grid	0.064	0	208.690 (5.42)	14.329 (0.19)	1.323 (0.81)	6.268 (3.59)
		MC-GMMS	0.017	1	204.144 (0.87)	15.776 (1.63)	2.681 (0.55)	11.356 (1.49)
		T-InfoGAN	**0.012**	**1**	**204.159 (0.89)**	**15.738 (1.60)**	**2.187 (0.06)**	**9.225 (0.64)**
	21:00–21:30	Observed	0.000	1	200.554 (0.000)	7.861 (0.00)	0.095 (0.00)	2.399 (0.00)
		Convolution	0.078	0	198.910 (1.64)	10.500 (2.64)	0.524 (0.43)	2.399 (0.15)
		MC-Grid	0.038	1	201.914 (1.36)	8.368 (0.51)	0.066 (0.03)	2.143 (0.11)
		MC-GMMS	0.014	1	200.236 (0.32)	8.184 (0.32)	0.077 (0.02)	2.192 (0.06)
		T-InfoGAN	**0.011**	**1**	**200.360 (0.19)**	**7.882 (0.02)**	**0.104 (0.01)**	**2.259 (0.01)**
2	8:00–8:30	Observed	0.000	1	422.919 (0.000)	23.198 (0.00)	−0.231 (0.00)	1.802 (0.00)
		Convolution	0.172	0	406.770 (16.15)	24.460 (1.26)	0.071 (0.30)	2.076 (0.27)
		MC-Grid	0.071	0	429.572 (6.65)	22.532 (0.67)	−0.735 (0.50)	2.402 (0.60)
		MC-GMMS	0.022	1	421.949 (0.97)	24.005 (0.81)	−0.406 (0.18)	1.900 (0.10)
		T-InfoGAN	**0.015**	**1**	**423.888 (0.97)**	**22.734 (0.46)**	**−0.194 (0.04)**	**1.569 (0.23)**
	21:00–21:30	Observed	0.000	1	284.958 (0.000)	21.495 (0.00)	−0.421 (0.00)	2.362 (0.00)
		Convolution	0.119	0	274.497 (10.46)	20.040 (1.46)	0.091 (0.51)	2.433 (0.07)
		MC-Grid	0.040	0	288.002 (3.04)	22.760 (1.27)	−0.400 (0.02)	2.130 (0.23)
		MC-GMMS	0.018	1	284.251 (0.71)	20.810 (0.69)	−0.285 (0.14)	2.227 (0.14)
		T-InfoGAN	**0.012**	**1**	**285.583 (0.62)**	**21.189 (0.31)**	**−0.528 (0.11)**	**2.362 (0.00)**

Kunpeng Zhang, Ning Jia, Zijian Liu, Liang Zheng*. (2019) A novel generative adversarial network for estimation of trip travel time distribution with trajectory data. *Transportation Research Part C: Emerging Technologies*, 108, 223-244.

1、基于生成对抗网络的行程时间估计

模型比较：

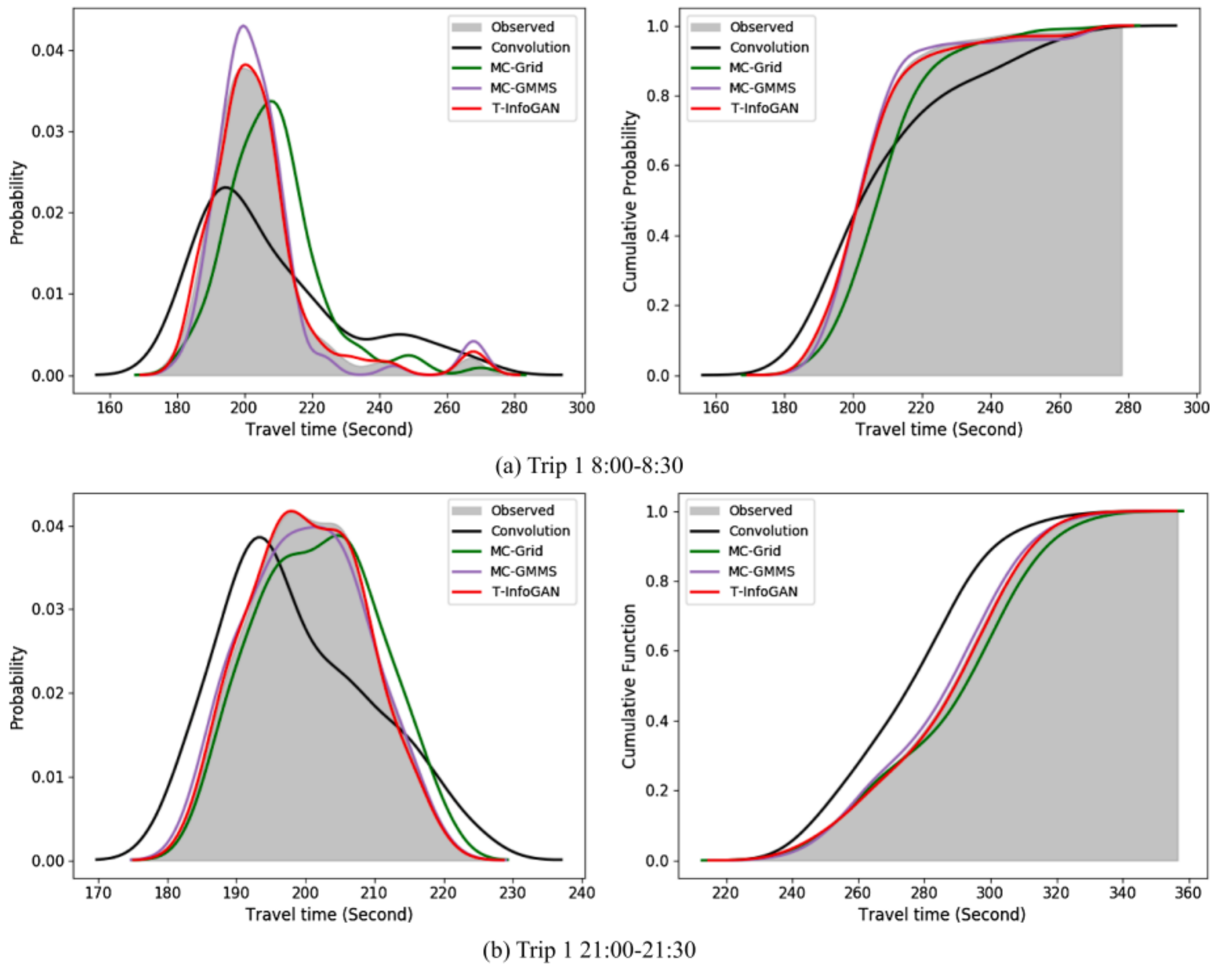
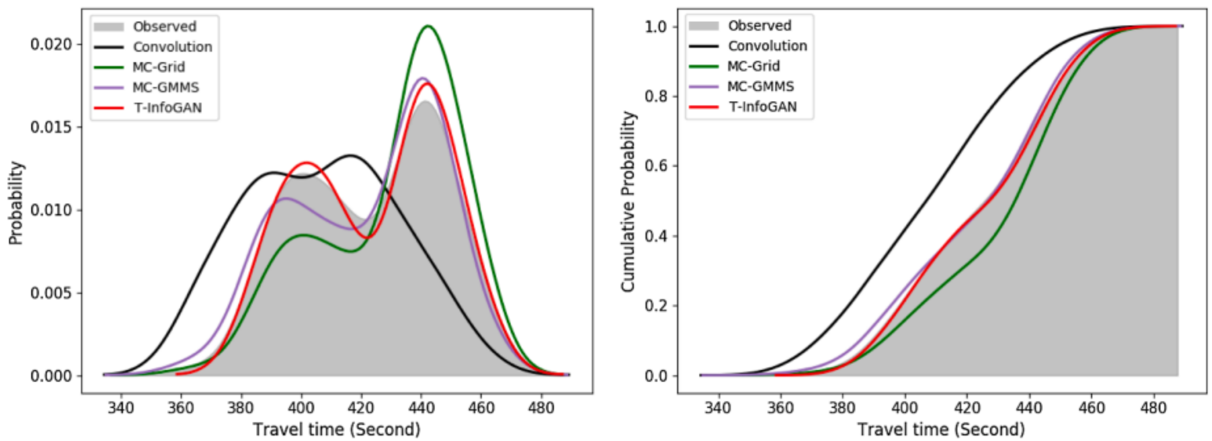


图4 Trip 1模型比较结果

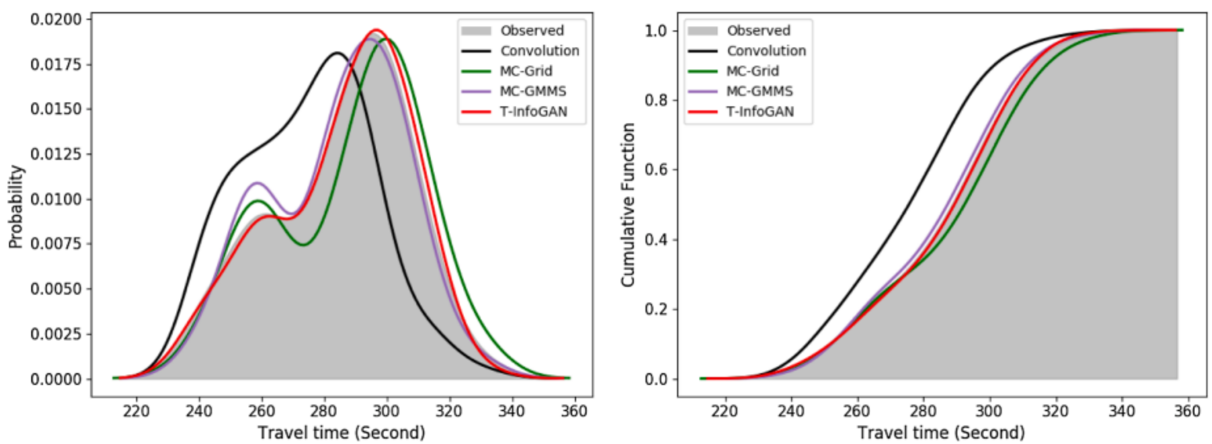
Kunpeng Zhang, Ning Jia, Zijian Liu, Liang Zheng*. (2019) A novel generative adversarial network for estimation of trip travel time distribution with trajectory data. *Transportation Research Part C: Emerging Technologies*, 108, 223-244.

1、基于生成对抗网络的行程时间估计

模型比较：



(c) Trip 2 8:00-8:30



(d) Trip 2 21:00-21:30

图5 Trip 2模型比较结果

Kunpeng Zhang, Ning Jia, Zijian Liu, Liang Zheng*. (2019) A novel generative adversarial network for estimation of trip travel time distribution with trajectory data. *Transportation Research Part C: Emerging Technologies*, 108, 223-244.

2、基于生成对抗网络的交通数据补全

问题描述：利用生成对抗网络拟合数据丰富路段的行程时间分布，借助交通状态在路网层面的时空相关性，补全数据缺失路段的行程时间

采用方法：

1. 模型框架： 行程时间补全生成对抗网络（Travel Time Imputation Generative Adversarial Network (TTI-GAN)）

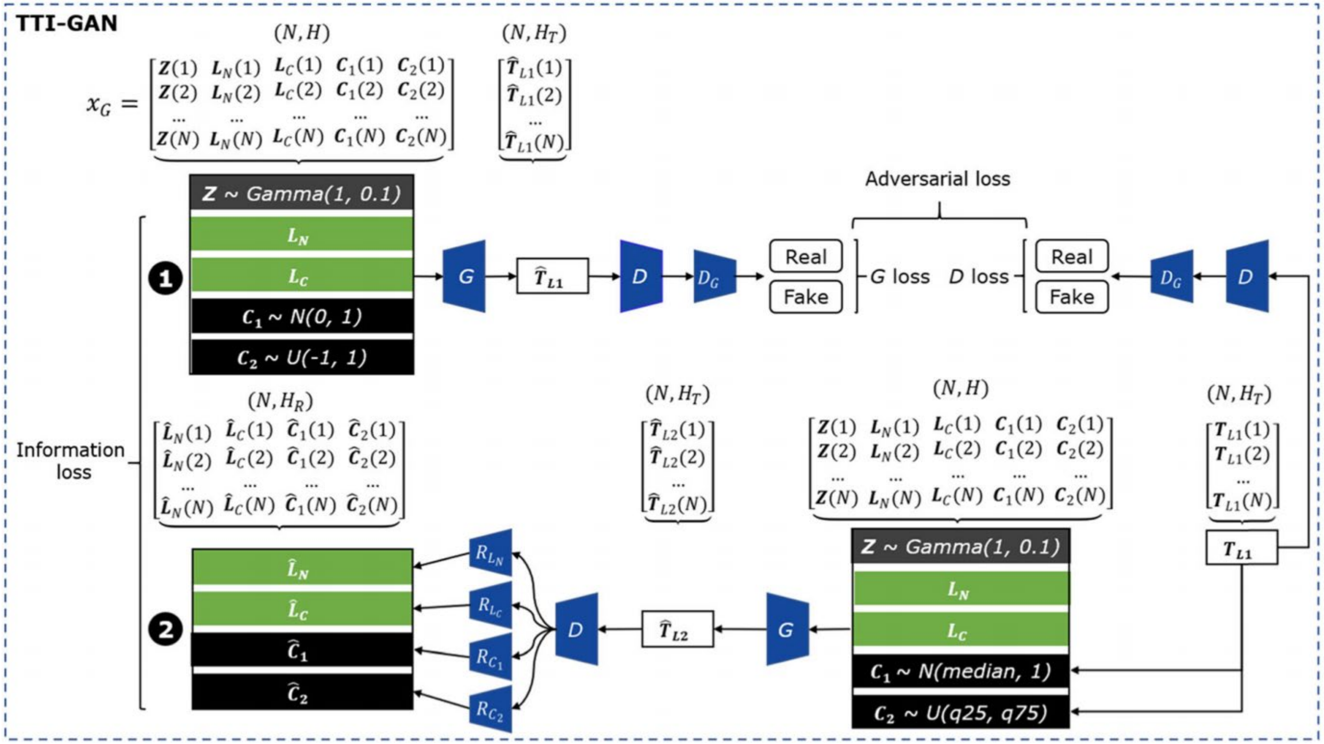


图6 行程时间补全生成对抗网络模型的内部结构

Kunpeng Zhang, Zhengbing He, Liang Zheng*. (2020) A generative adversarial network for travel times imputation using trajectory data. *Computer-Aided Civil and Infrastructure Engineering*.

2、基于生成对抗网络的交通数据补全

2. 路网编码： 利用自然语言处理领域中的词嵌入（Word Embedding）方法对路网文本数据进行编码，生成计算机可以理解且易于处理的路网语义向量。

[l_1, 2020.01.01 08:00:00, c_1, c_2]

0.25, 0.1, 0.53, 0.89, 0.64, …

图7 路网编码示例

Kunpeng Zhang, Zhengbing He, Liang Zheng*. (2020) A generative adversarial network for travel times imputation using trajectory data. *Computer-Aided Civil and Infrastructure Engineering*.

2、基于生成对抗网络的交通数据补全

补全结果：

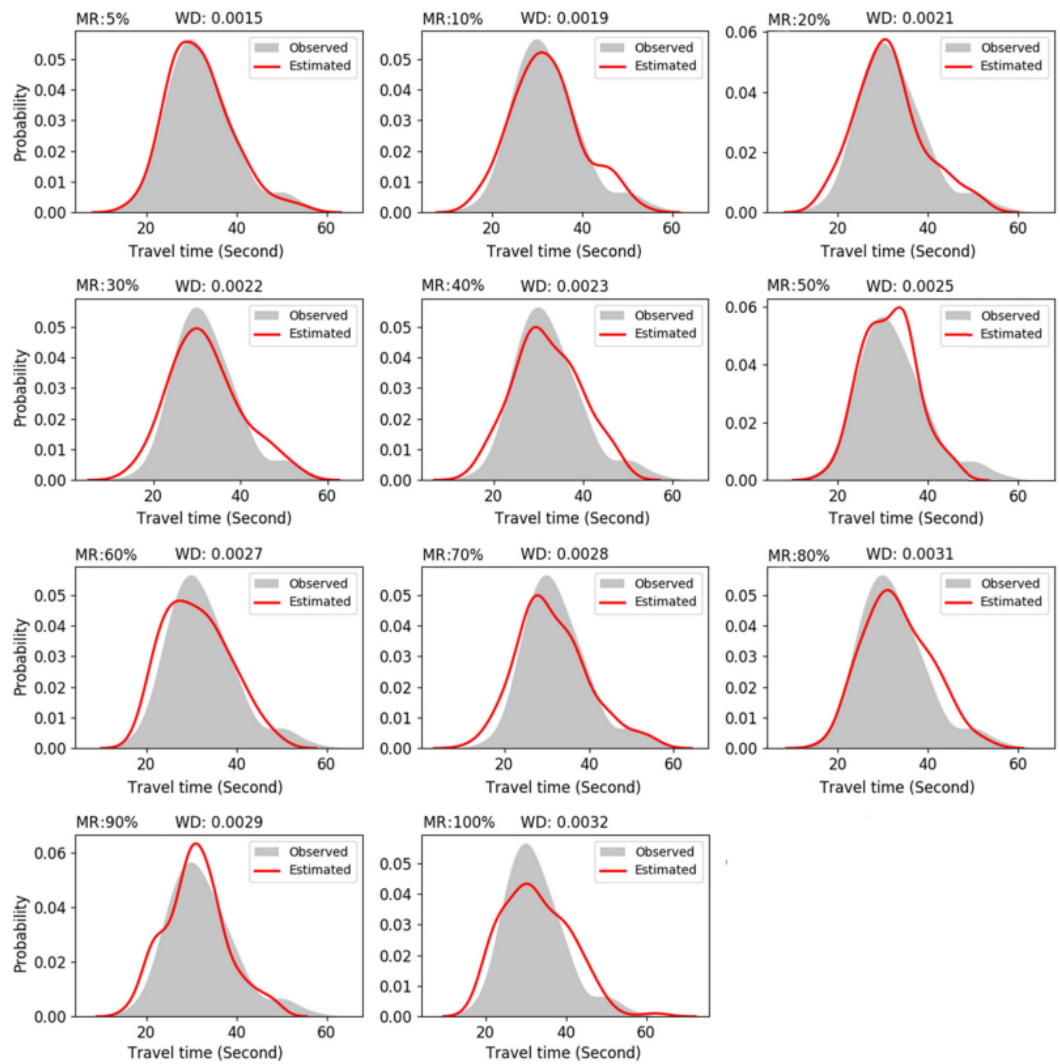


图8 不同缺失率情形下的行程时间数据补全结果

Kunpeng Zhang, Zhengbing He, Liang Zheng*. (2020) A generative adversarial network for travel times imputation using trajectory data. *Computer-Aided Civil and Infrastructure Engineering*.

2、基于生成对抗网络的交通数据补全

模型比较：

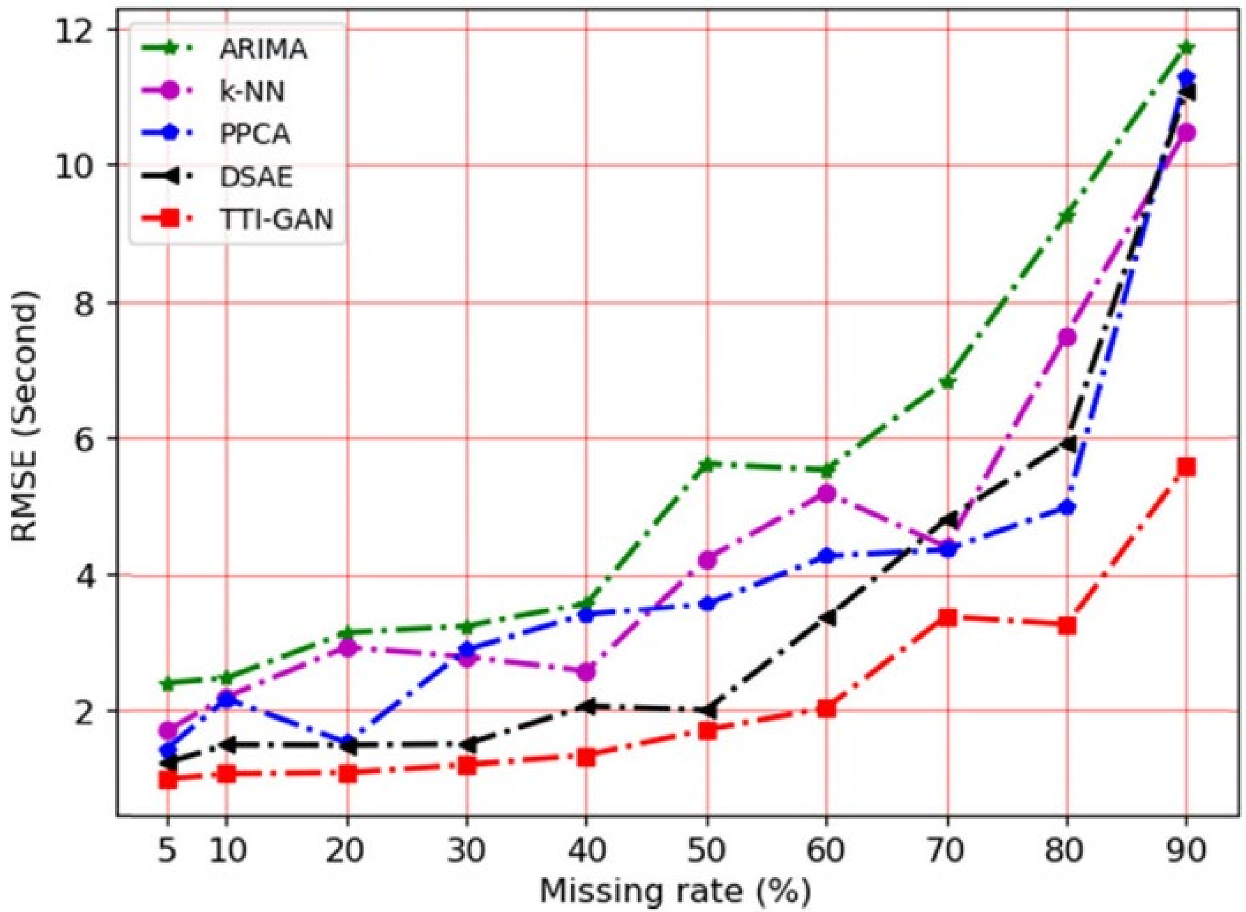


图9 模型比较结果

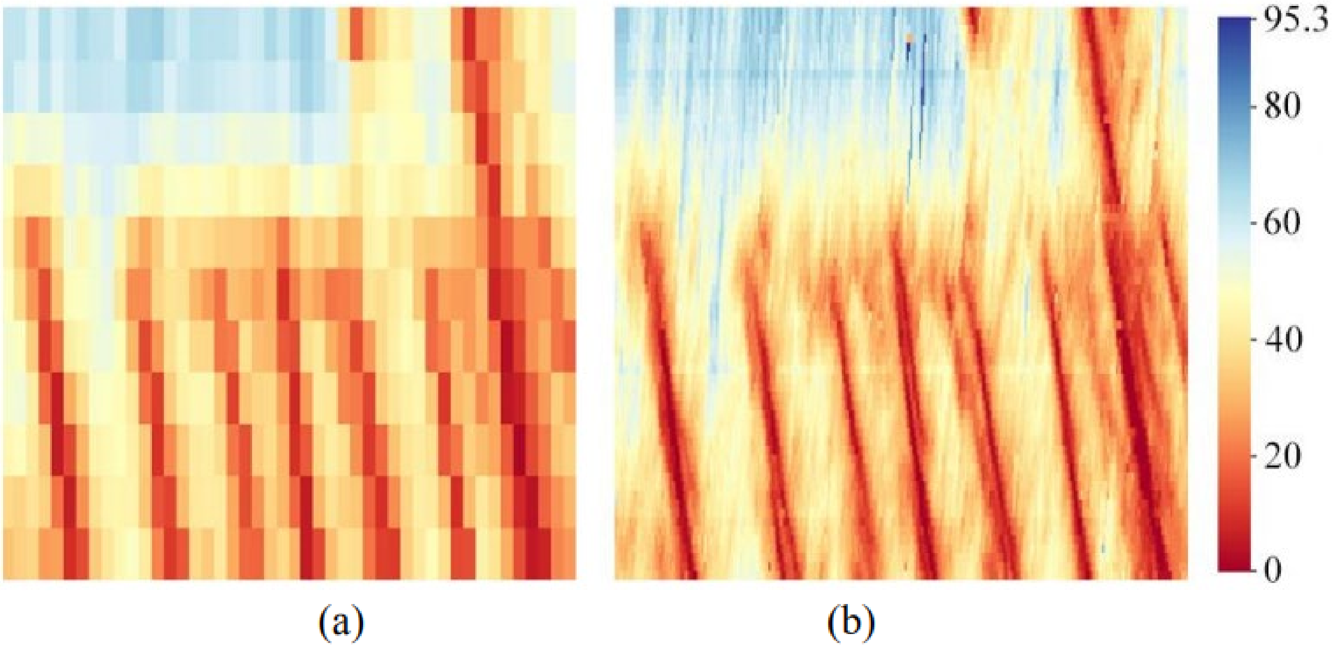
Kunpeng Zhang, Zhengbing He, Liang Zheng*. (2020) A generative adversarial network for travel times imputation using trajectory data. *Computer-Aided Civil and Infrastructure Engineering*.

3、基于生成对抗网络的交通状态重构

问题描述：将交通状态信息转化为二维交通时空图，以低分辨率时空图为输入，获取高分辨率时空图，重建数据不足路段的交通状态。

采用方法：

1. 交通时空图：



(a) Low-resolution STD. (b) High-resolution STD. *Note:* Color denotes traffic speed.

图10 交通时空图

Kunpeng Zhang, Lan Wu, Ning Jia, Liang Zhao, Zhengbing He*. (2020) TSR-GAN: Generative Adversarial Networks for Traffic State Reconstruction with Trajectory Data. *IEEE Transactions on Intelligent Transportation Systems*. **(在投)**

3、基于生成对抗网络的交通状态重构

2. 模型框架：交通状态重构生成对抗网络（Traffic State Reconstruction Generative Adversarial Networks，TSR-GAN）

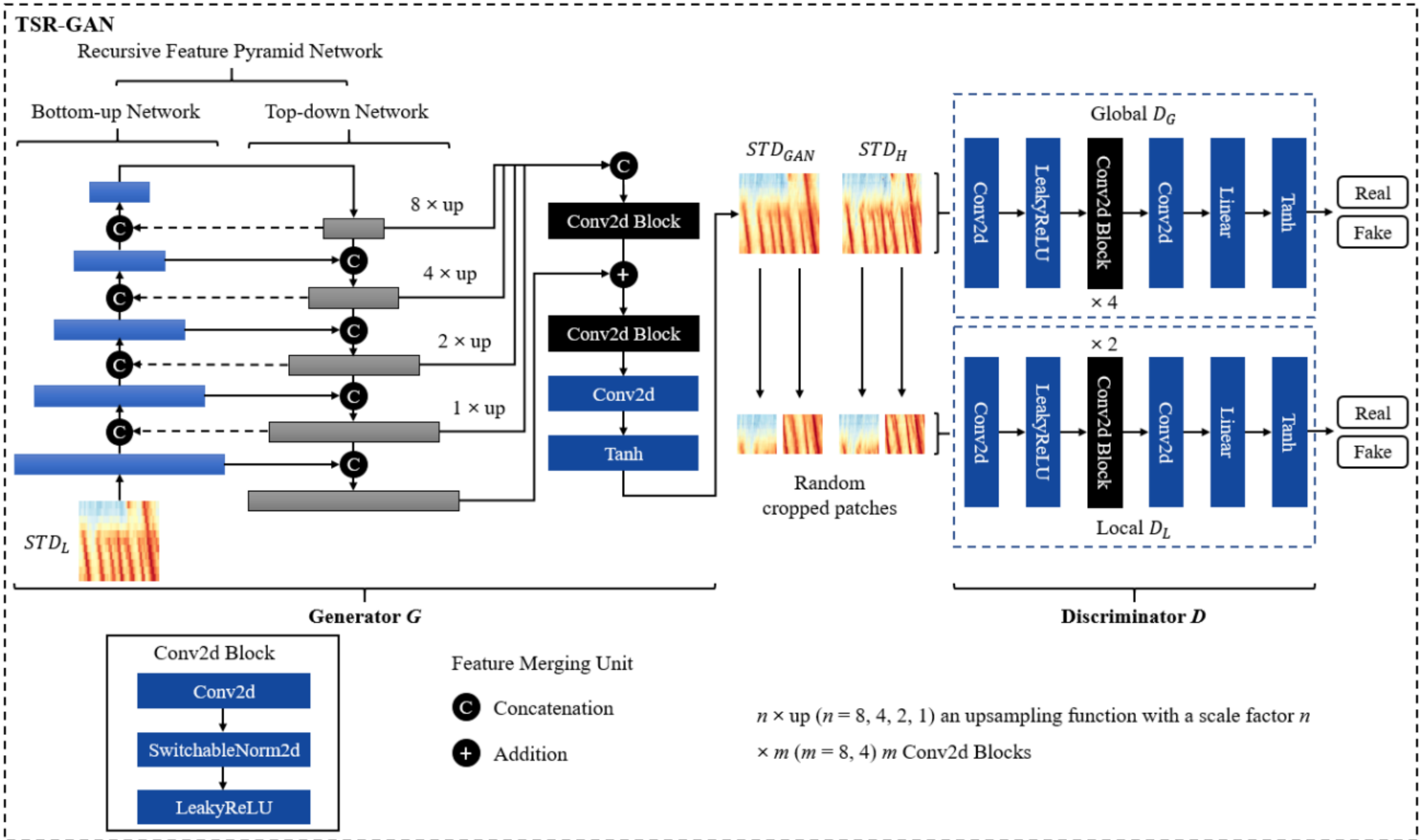
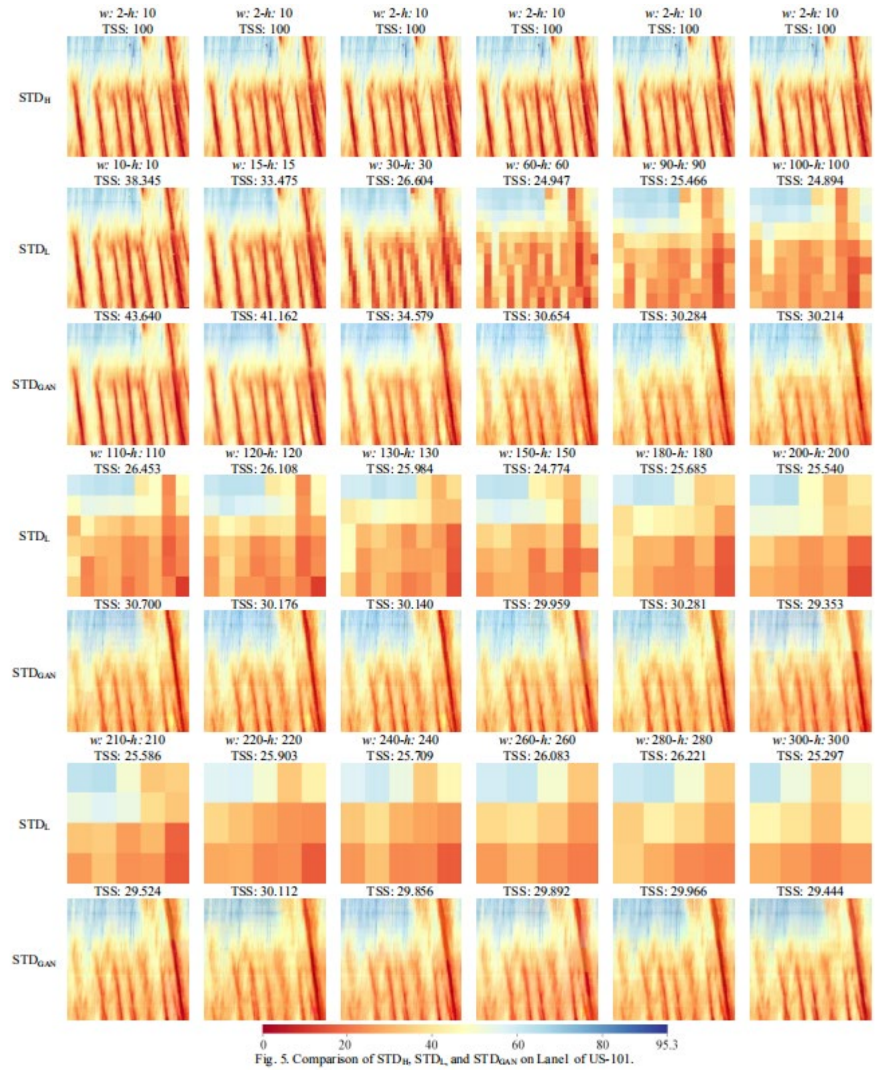


图11 交通状态重构生成对抗网络的内部结构

Kunpeng Zhang, Lan Wu, Ning Jia, Liang Zhao, Zhengbing He*. (2020) TSR-GAN: Generative Adversarial Networks for Traffic State Reconstruction with Trajectory Data. *IEEE Transactions on Intelligent Transportation Systems*. **(在投)**

3、基于生成对抗网络的交通状态重构

补全结果：



高分辨率时空图

低分辨率时空图

TSR-GAN生成的时空图

低分辨率时空图

TSR-GAN生成的时空图

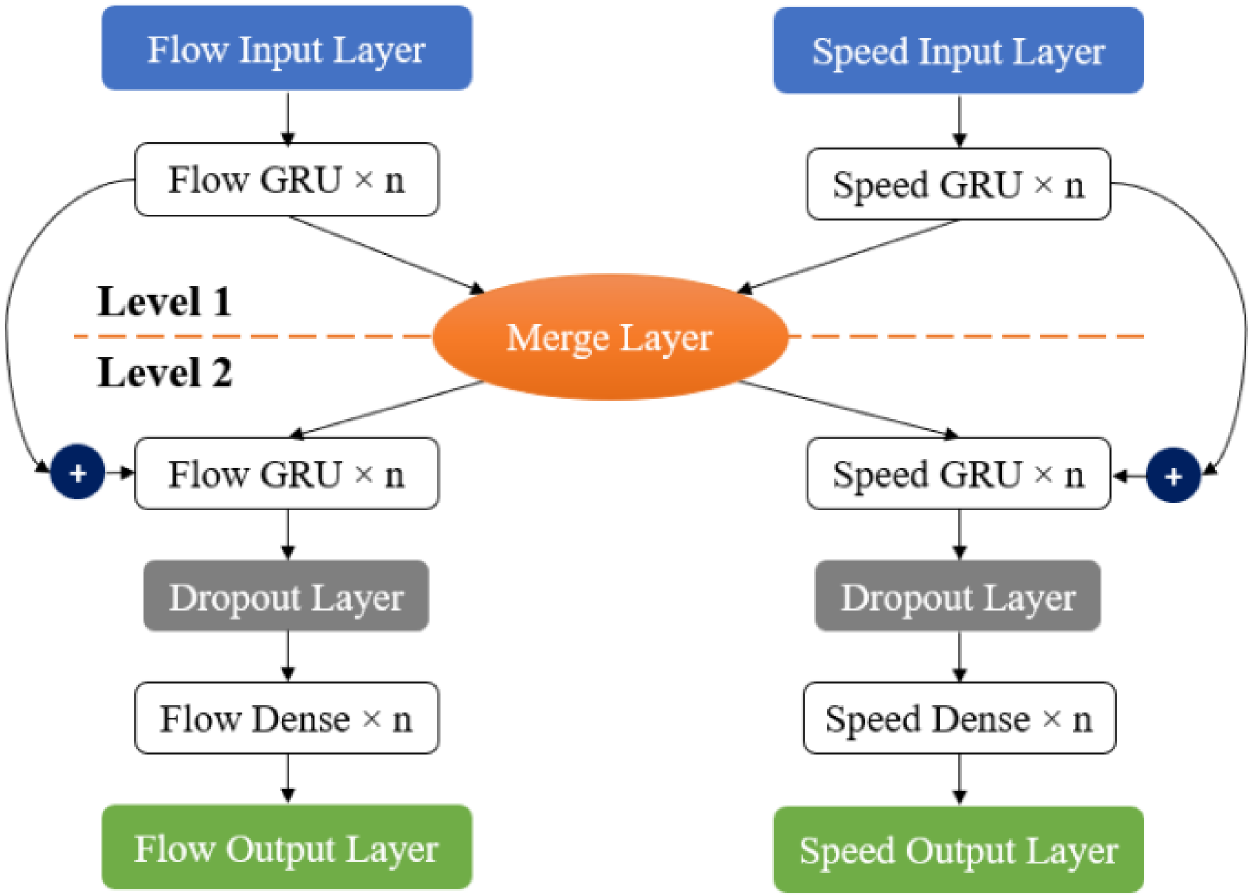
低分辨率时空图

TSR-GAN生成的时空图

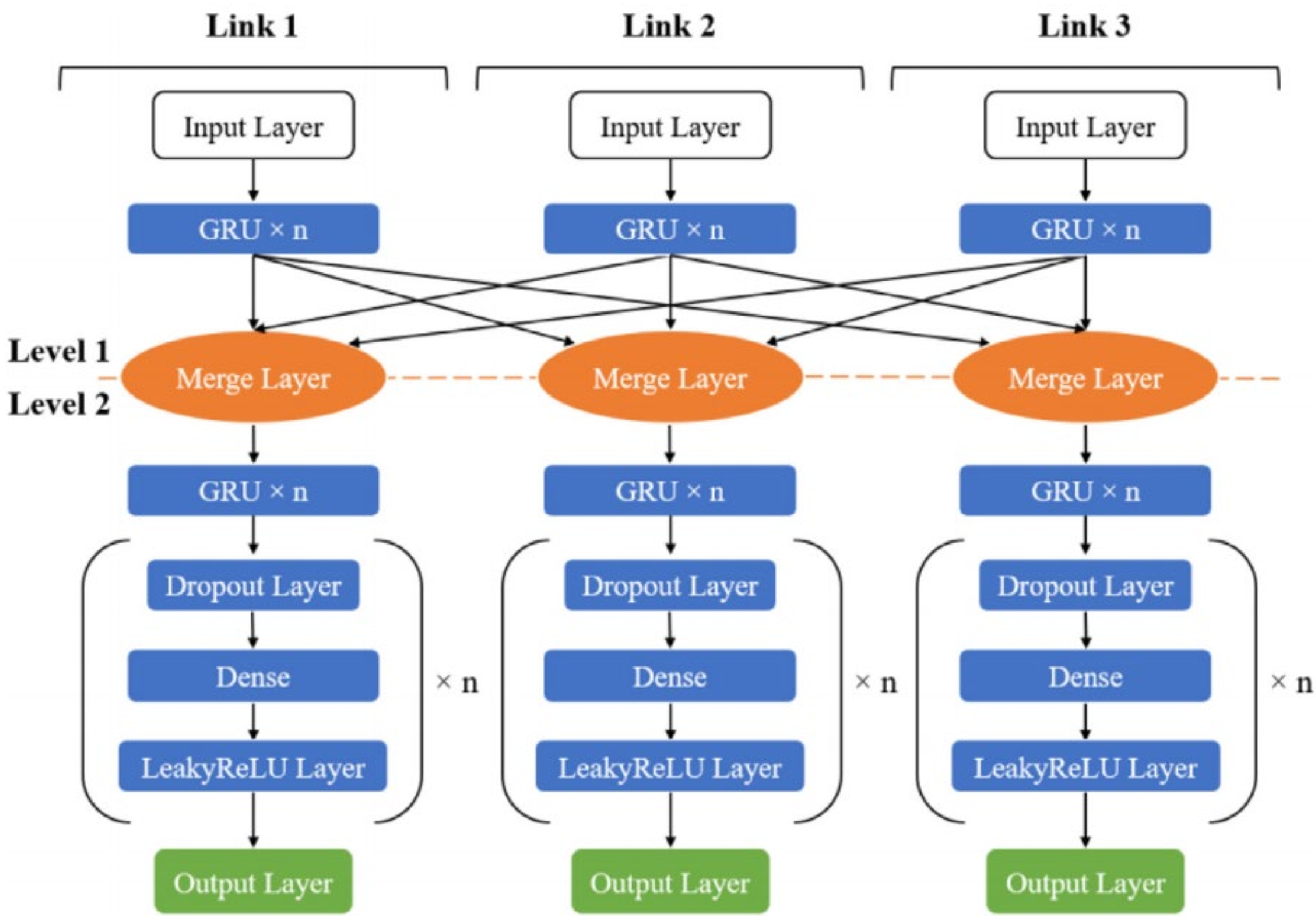
图12 不同分辨率情形下的交通状态重构结果

Kunpeng Zhang, Lan Wu, Ning Jia, Liang Zhao, Zhengbing He*. (2020) TSR-GAN: Generative Adversarial Networks for Traffic State Reconstruction with Trajectory Data. *IEEE Transactions on Intelligent Transportation Systems*. **(在投)**

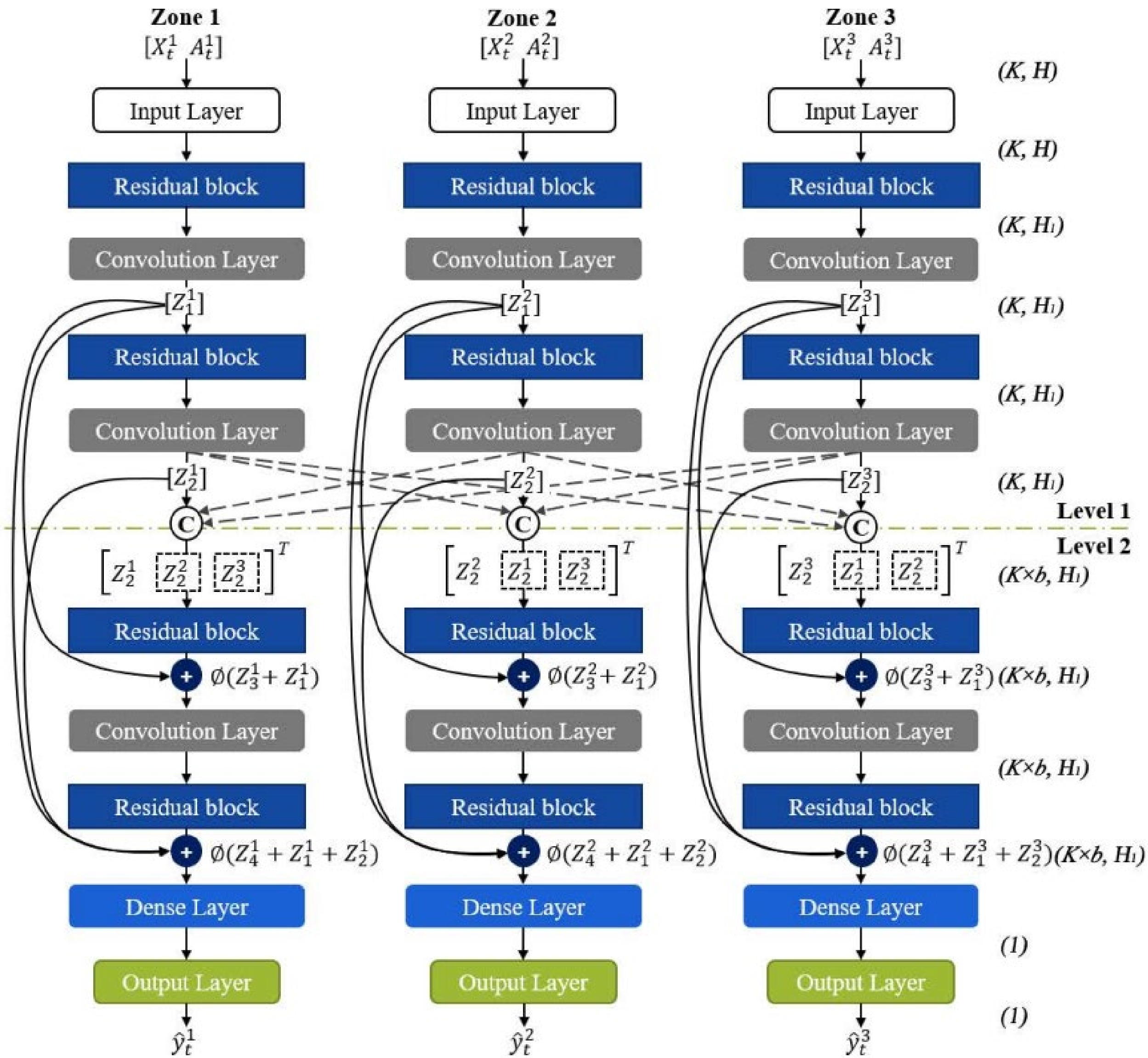
4、基于多任务学习的短时交通状态估计



4、基于多任务学习的短时交通状态估计



4、基于多任务学习的短时交通状态估计



5、近年来发表论文

1. **Kunpeng Zhang**, Liang Zheng*, Zijian Liu*, and Ning Jia. (2019) A deep learning based multitask model for network-wide traffic speed prediction. *Neurocomputing*, 396, 438-450. (SCI, 影响因子4.438)
2. **Kunpeng Zhang**, Zijian Liu*, and Liang Zheng*. (2019) Short-term prediction of passenger demand in multi-zone level: Temporal convolutional neural network with multi-task learning. *IEEE Transactions on Intelligent Transportation Systems*, 21(4), 1480-1490. (SCI, 影响因子6.319)
3. **Kunpeng Zhang**, Ning Jia, Zijian Liu, Liang Zheng*. (2019) A novel generative adversarial network for estimation of trip travel time distribution with trajectory data. *Transportation Research Part C: Emerging Technologies*, 108, 223-244. (SCI, 影响因子6.077)
4. Liang Zheng, Huimin Huang, Chuang Zhu, **Kunpeng Zhang***. (2020) A tensor-based K-nearest neighbors method for traffic speed prediction under data missing. *Transportmetrica B: Transport Dynamics*, 8(1):182-199. (SCI, 影响因子2.214)
5. **Kunpeng Zhang**, Zhengbing He, Liang Zheng*. (2020) A generative adversarial network for travel times imputation using trajectory data. *Computer-Aided Civil and Infrastructure Engineering*. (SCI, 影响因子8.552)
6. **Kunpeng Zhang**, Lan Wu, Ning Jia, Liang Zhao, Xiaoliang Feng, Zhengbing He*. (2020) TSR-GAN: Generative Adversarial Networks for Traffic State Reconstruction with Trajectory Data. *IEEE Transactions on Intelligent Transportation Systems*. (SCI, 影响因子6.319) (在投)

谢谢！请各位批评指正！

6、行程时间估计软件系统