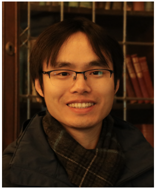


Xinyu Chen

Postdoc, MIT (now)
Advisor: Prof. Jinhua Zhao

PhD, University of Montreal ('23)
Civil Engineering (Transportation)

Interests

- Advanced computing for engineering
- Urban system & human mobility
- Data-driven traffic flow modeling
- Climate system monitoring
- Machine learning & data science
- Optimization & math programming

Collaboration w/ CEE, EECS, Stat, Math

Interdisciplinary Research

Computational Engineering in CEE

PhD (ML for Transportation)

- **Traffic imputation** w/ tensor decomposition
  Chen et al.'19; Chen et al.'21 in Transportation Research Part C (cited 300+)
  Chen et al.'22 in IEEE Transactions Intelligent Transportation Systems (cited 100+)
  Chen et al.'24 in IEEE Transactions on Knowledge and Data Engineering (TKDE)
- **Mobility prediction** w/ nonconvex optimization
  Chen & Sun'22 in IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI) (cited 250+)
  Chen et al.'24 in INFORMS Journal on Computing (IJOC)
  Chen et al.'25, accepted in Transportation Science
- **Dynamic climate pattern discovery**
  Chen et al.'24 in TKDE

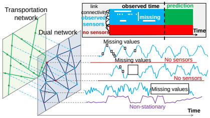
Postdoc (ML + Optimization for Spatiotemporal Data)

- **Tensor decomposition for ML**
  Chen et al.'25, major revision in TPAMI
- **Causal inference from climate systems**
  Chen et al.'25, 2nd-round review in TKDE
- **Mobility periodicity quantification**
  Ready for submission to IJOC

Research Contributions

- Formulating challenging engineering problems (w/ practical contributions)

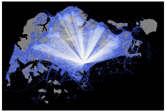
Traffic Imputation



Missing data in transport

Matrix/tensor decomposition
Temporal dynamics

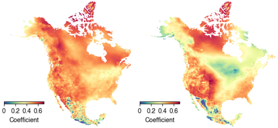
Mobility Pattern Discovery



Singapore movement

Dynamical system modeling
Tensor decomposition

Climate Seasonality Qualification

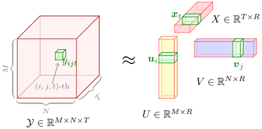


2000s 2010s

Interpretable ML
Mixed-integer programming

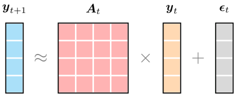
- Advancing ML development (w/ methodological contributions)

Tensor decomposition



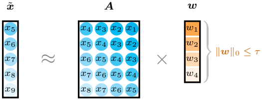
Integrate traffic flow patterns

Dynamic mode decomposition



Formulate dynamic patterns

Sparse autoregression



Find sparse autocorrelations

Reproducible Research for Engineering

- The last mile of AI for computational engineering

Human mobility & smart cities
Data-driven transport analytics
Spatiotemporal data modeling
Interpretable ML for causal inference
Tensor decomposition for ML
...

jupyter colab NumPy pandas CuPy

Directions & Topics **Reproducible Research**

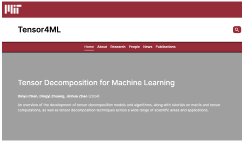
- Advancing ML development with open-source research

transdim

(1,200+ GitHub stars)

ML for Transport Data Imputation

https://github.com/xinychen/transdim



Tensor Decomposition for ML

(ML initiative)

Math & ML Tutorials

https://sites.mit.edu/tensor4ml

Spatiotemporal Data Modeling

(Data valorization initiative)

Model Development of ML & Data Science

https://spatiotemporal-data.github.io

Building Research Impact at Vanderbilt University

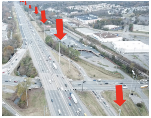
- Contributing to CEE, College of Connected Computing, Data Science Institute

Infrastructure — Urban systems, Highways

Data Availability — Collecting data, Releasing data

Data Valorization — Processing data, Improving data quality, Formulating problems

Computational Engineering — Machine learning, Deep learning, Matrix computations, Nonconvex optimization, Mathematical programming



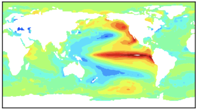
(Source: arXiv:2311.10888)

I-24 MOTION

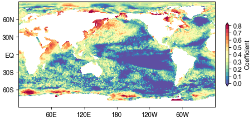
Vehicle trajectory

Vision: Connecting engineering with data, mathematics, and AI.

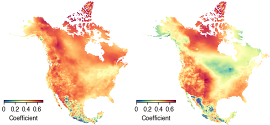
- Contributing to Vanderbilt Center for Sustainability, Energy and Climate



El Niño patterns



Sea surface temperature seasonality



Climate seasonality (2000s vs. 2010s)

- Supervising students: Undergraduate Summer Research Program; Immersion VU; Experience Vanderbilt; Serving for PhD committee
- Research group: Developing ML and optimization in transportation & mobility analytics; Developing innovative AI tools for computational engineering.

Teaching & Grant

- **Teaching Interests & Plan at Vanderbilt University**
  - Formats: Tutorial, data example, LaTeX graphic, Python code, GitHub repository, and course website

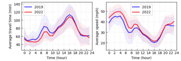


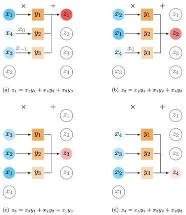
Figure 6. Average travel time and speed from area 32 (i.e., Downtown) to area 76 (i.e., Airport) in both 2019 and 2022.

```
import numpy as np
import matplotlib.pyplot as plt

fig = plt.figure(figsize = (8, 2.5))
ax = fig.add_subplot(1, 2, 1)
# Average travel time in 2019
m1 = df1.groupby(['hour'])['Trip Seconds'].mean().values / 30
s1 = df1.groupby(['hour'])['Trip Seconds'].std().values / 30
plt.plot(m1, color = 'blue', linewidth = 1.8, label = '2019')
upper = m1 + s1
lower = m1 - s1
x_bound = np.append(np.append(np.append(np.array([0, 0]), np.arange(0, 24)),
                              np.array([24 - 1, 24 - 1])), np.arange(24 - 1, -1,
y_bound = np.append(np.append(np.append(np.array([upper[0], lower[0]]), lower),
                              np.array([lower[-1], upper[-1]])), np.flip(upper))
plt.fill(x_bound, y_bound, color = 'blue', alpha = 0.05)

# Average travel time in 2022
m1 = df2.groupby(['hour'])['Trip Seconds'].mean().values / 30
s1 = df2.groupby(['hour'])['Trip Seconds'].std().values / 30
plt.plot(m1, color = 'red', linewidth = 1.8, label = '2022')
upper = m1 + s1
lower = m1 - s1
```

Data-Driven Transportation Analytics

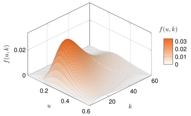


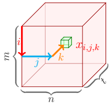
(a) $z_1 = x_1 y_1 + x_4 y_2 + x_3 y_3$ (b) $z_2 = x_2 y_1 + x_1 y_2 + x_4 y_3$

(c) $z_3 = x_3 y_1 + x_2 y_2 + x_1 y_3$ (d) $z_4 = x_4 y_1 + x_3 y_2 + x_2 y_3$

Figure 2. Illustration of the circular convolution between $\boldsymbol{x} = (x_1, x_2, x_3, x_4)^\top$ and $\boldsymbol{y} = (y_1, y_2, y_3)^\top$. (a) Computing z_1 involves $x_0 = x_4$ and $x_{-1} = x_3$. (b) Computing z_2 involves $x_0 = x_4$. The figure inspired by Prince (2023).

Computing Fundamentals in CEE



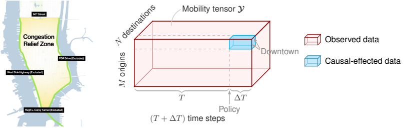


Spatiotemporal Modeling in CEE

- **Grant & Funding**

Transit-Centric Smart Mobility System with ML (DOE)

(PI: Jinhua Zhao. **Role**: Senior Researcher)



Causal inference for congestion pricing (NSF, submitted)

(PI: Jinhua Zhao; Co-PI: Ankur Moitra. **Role**: Senior Researcher)