



# **Professorship in Transportation Analytics**

## **(Research Plan)**

**Xinyu Chen**

Postdoctoral Associate, MIT

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## Research Interests

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- Transportation analytics
  - Sustainable transportation such as micromobility (e.g., bikeshare systems and E-scooter)
  - Smart cities (e.g., data-driven policymaking)
  - Congestion analysis (e.g., congestion pricing & causal inference)
- Big data
  - Human mobility data analytics
  - Data standardization
  - Data valorization
- Machine learning & optimization
  - Tensor computations & decomposition
  - Interpretable machine learning
  - Uncertainty qualification
  - Linear/Nonlinear programming

# Proposal & Funding Opportunity

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- ERC Starting Grant
  - 2-7 years of experience since completion of PhD
  - Scientific track record showing great promise
  - Excellent research proposal, any field of research
  - Up to 1.5 million for a period of 5 years
- Horizon Europe
  - Research and innovation funding programme until 2027
  - (Pillar II) Global Challenges and European Industrial Competitiveness: Climate, Energy and Mobility cluster
- DFG
  - e.g., Emmy Noether Programme (postdoc & junior professor)



**European Research Council**  
Established by the European Commission



Deutsche  
Forschungsgemeinschaft

# Transportation Data Imputation & Prediction

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**transdim:** Machine learning for transportation data imputation and prediction

- ① Imputation with **tensor decomposition**, see [Chen et al.'18](#) in TR-C
- ② Traffic imputation with **Bayesian Gaussian tensor factorization**, see [Chen et al.'19\(a,b\)](#) in TR-C
- ③ Traffic imputation with **tensor completion**, see [Chen et al.'20](#), [Chen et al.'21](#) in TR-C, [Chen et al.'22](#) in IEEE TITS
- ④ Traffic imputation with **Laplacian convolutional representation**, see [Chen et al.'24](#) in IEEE TKDE
- ⑤ Traffic prediction with **Bayesian temporal factorization**, see [Chen & Sun'22](#) in IEEE TPAMI
- ⑥ Traffic prediction with **temporal matrix factorization**, see [Chen et al.'24](#) in IJOC



transdim

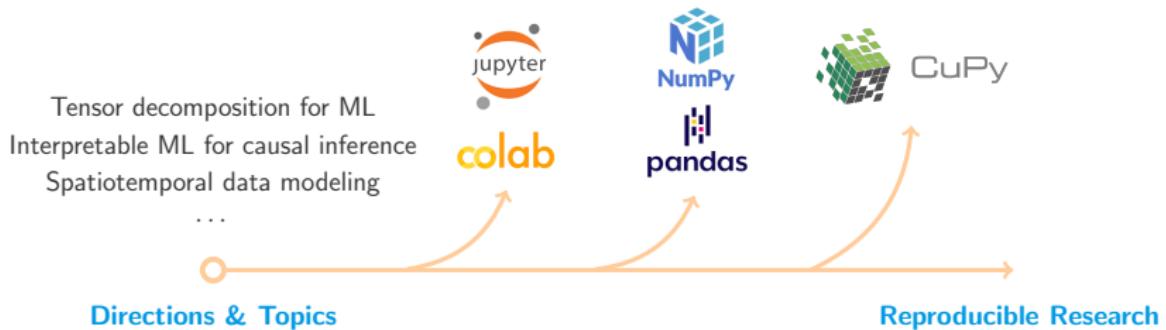
(1,200+ GitHub stars)

Formulate data-driven transportation analytics with mathematics and machine learning.

All of these studies are reproducible at <https://github.com/xinychen/transdim>.

# Working & Future Directions

- The last mile of AI for transportation analytics



- Current collaboration



Prof. Jinhua Zhao  
(MIT DUSP)  
AI & Human mobility



Prof. Ankur Moitra  
(MIT Math)  
Theoretical ML



Prof. Cathy Wu  
(MIT CEE)  
Reproducible research for transport

# Tensor Decomposition for Machine Learning

## Tensor4ML:

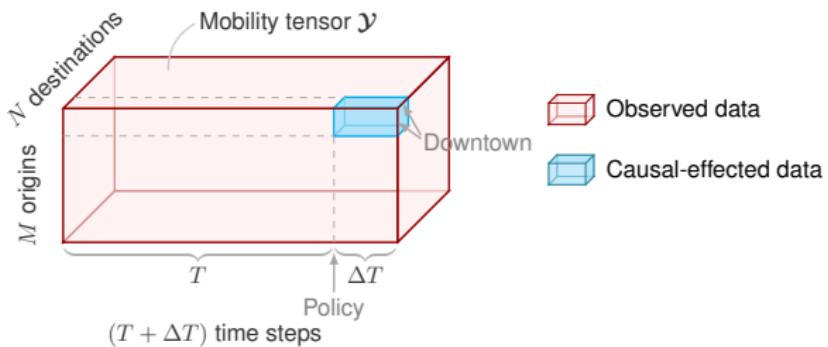
- An overview of the development of tensor decomposition models, algorithms, and applications.
- Project website: <https://sites.mit.edu/tensor4ml>
- GitHub: <https://github.com/xinyuchen/Tensor4ML>
- Team: **Xinyu Chen**, Dingyi Zhuang, Ankur Moitra, Jinhua Zhao

The screenshot shows a desktop browser displaying the Tensor4ML project website. The address bar shows 'https://sites.mit.edu/tensor4ml'. The page has a red header bar with the MIT logo and the text 'Tensor4ML'. Below the header is a navigation bar with links for 'Home', 'About', 'Research', 'People', 'News', and 'Publications'. The main content area features a large image of a brain with a grid overlay, followed by the title 'Tensor Decomposition for Machine Learning' and the names 'Xinyu Chen, Dingyi Zhuang, Jinhua Zhao (2024)'. A descriptive paragraph follows, and at the bottom right is a small '...' button. On the right side of the page, there is a vertical sidebar with a red header containing a search icon and a red footer containing a red '...' button. The sidebar lists several topics with checkmarks: '✓ Introduction', '✓ What are tensors?', '✓ Foundation of tensor computations', '✓ Foundation of optimization', '✗ CP decomposition', '✗ Tucker decomposition', '✗ Bayesian tensor decomposition', and '✗ ...'.

- Highlights: Tutorials, intuitive graphics (LaTeX), Python implementation, data examples

# Interpretable Machine Learning for Causal Inference

- NSF proposal (submitted in June 2024)
  - Tensorial Machine Learning Methods for Causal Inference from Spatiotemporal Data
  - Team: Jinhua Zhao (PI), Ankur Moitra (Co-PI), **Xinyu Chen** (Senior Researcher, building ideas & writing proposal)



Causal effect imputation framework on urban human mobility data with {origin, destination, time step}-dimensional tensors.

- **Human mobility:** Estimating causal-effected data without policy intervention such as congestion pricing in NYC.
- Prior work: Spatiotemporal autoregression with tensor decomposition, see [Chen et al.'24](#) in IEEE TKDE

# Spatiotemporal Data Modeling

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Leading the **big data initiative**:

- Reproducible Research in Spatiotemporal Data Modeling with Machine Learning and AI Techniques
- Website: <https://spatiotemporal-data.github.io>



A quick look (example pages):

- Data:  
<https://spatiotemporal-data.github.io/Chicago-mobility/taxi-data>
- Tutorial for explaining machine learning:  
[https://spatiotemporal-data.github.io/posts/ts\\_conv](https://spatiotemporal-data.github.io/posts/ts_conv)

# Extending Research Boundaries

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- Possible collaboration in several directions at TUM:



**Prof. Rolf Moeckel**

Travel behavior  
& human mobility



**Prof. Constantinos Antoniou**

Transportation system  
engineering



**Prof. Maximilian Schiffer**

Machine learning & mathematical  
programming



**Prof. Jingui Xie**

Data-driven  
decision-making

- Collaboration outside TUM in Europe:



**Prof. Jakob Runge**  
(TU Dresden)

Causal inference for  
time series data



**Prof. Filipe Rodrigues**  
(DTU)

Machine learning for  
smart mobility

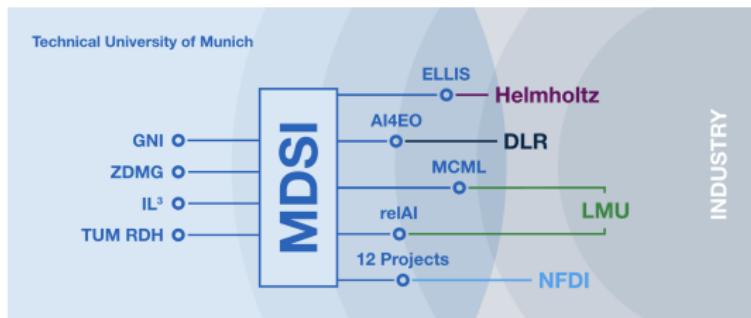


**Prof. Vassilis Digalakis Jr**  
(HEC Paris)

Trustworthy machine learning  
& optimization

# Extending Research Boundaries

- Contributing to:
  - Heilbronn Data Science Institute (build-up phase) & Munich Data Science Institute
  - Research & Education missions of Dieter Schwarz Foundation



- Building close ties to research institute and industry:





# Thanks for your attention!

Any Questions?

## About me:

- 🏠 Homepage: <https://xinychen.github.io>
- 🏠 MIT sites: <https://sites.mit.edu/xinychen>
- ✉ How to reach me: [xinychen@mit.edu](mailto:xinychen@mit.edu)