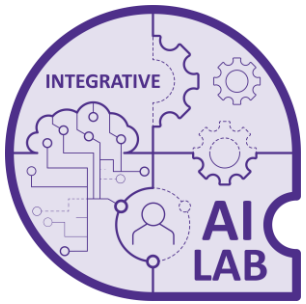
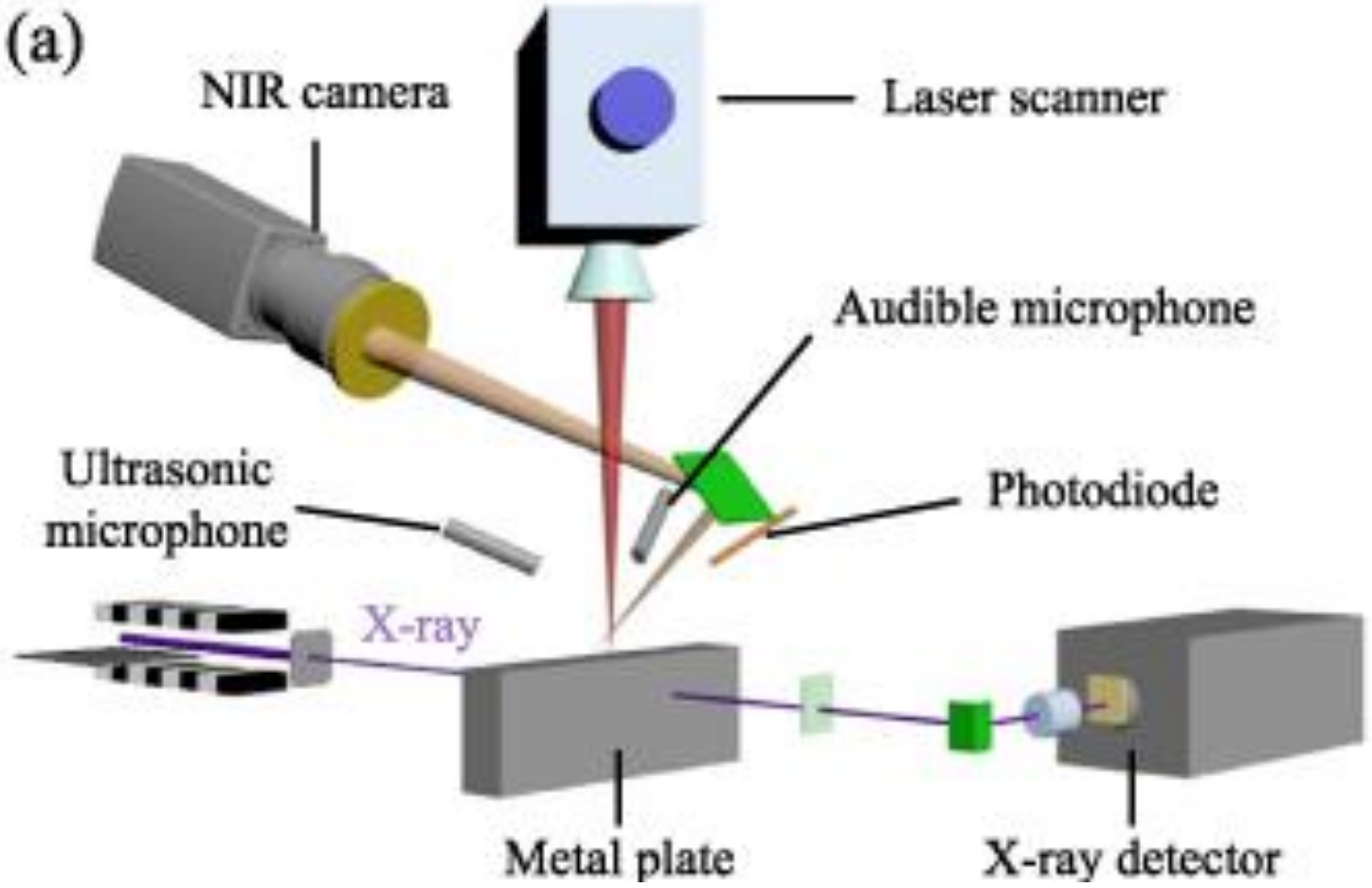
Interoperable Representations: Building Blocks for Manufacturing Intelligence



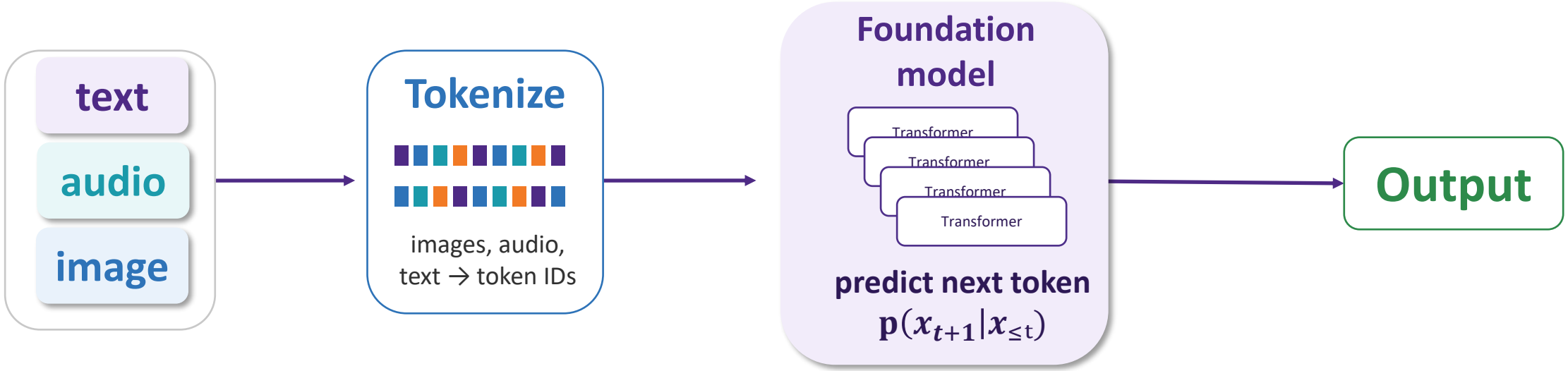
Naichen Shi
Assistant Professor, Northwestern University
Website: https://naichenshi.github.io/

Laser Additive Manufacturing



[1] Ren, Zhongshu, et al. "Sub-millisecond keyhole pore detection in laser powder bed fusion using sound and light sensors and machine learning." Materials Futures 3.4 (2024): 045001.

Current AI Models

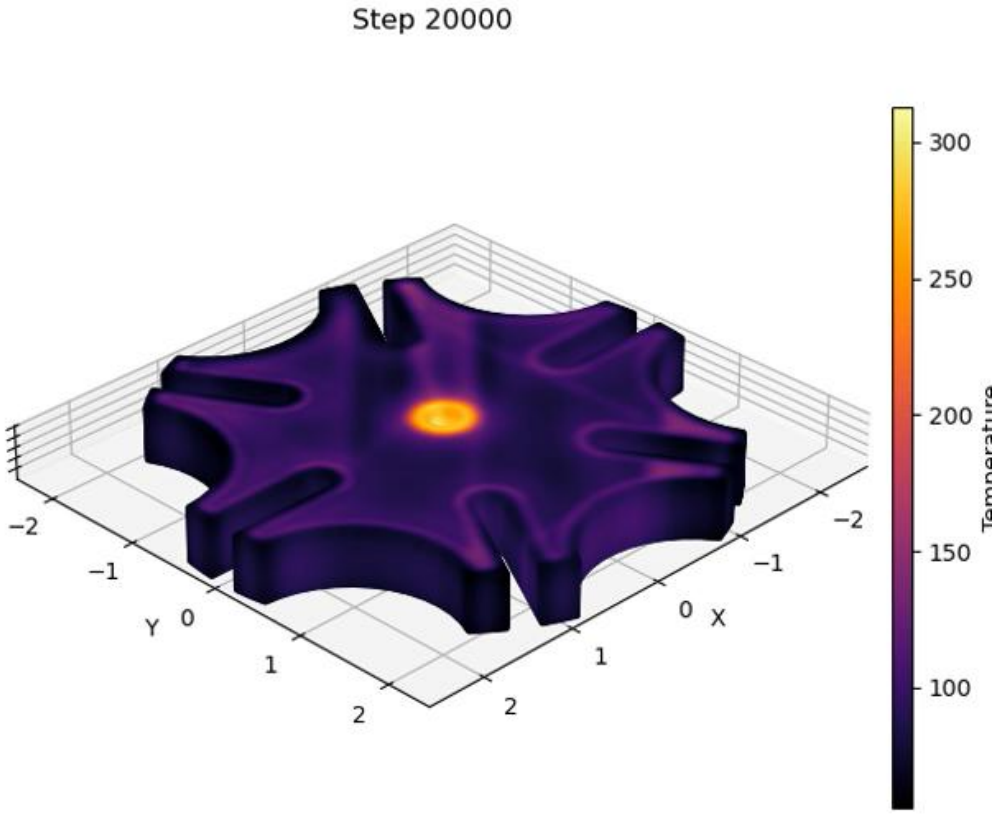


Data challenge

Token-prediction pipelines assume curated and aligned data with **interoperable** tokens, while manufacturing streams are heterogeneous and noisy.

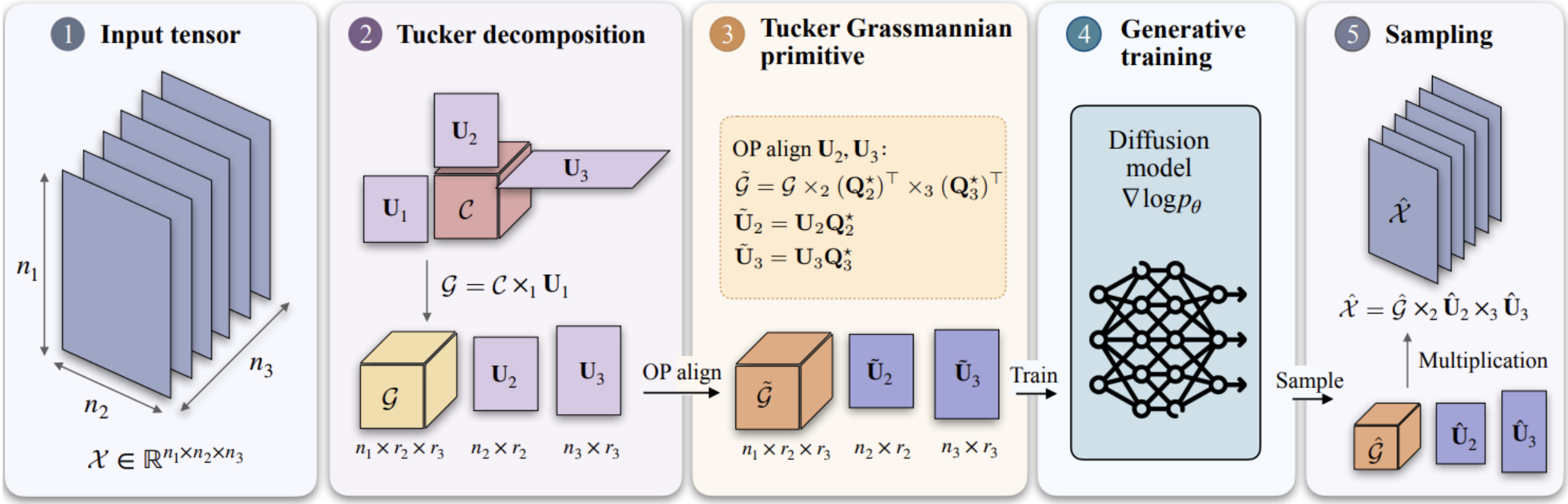
Can we build interoperable representations to bridge manufacturing systems with AI?

Data Volume is Large, Yet Information is Scarse



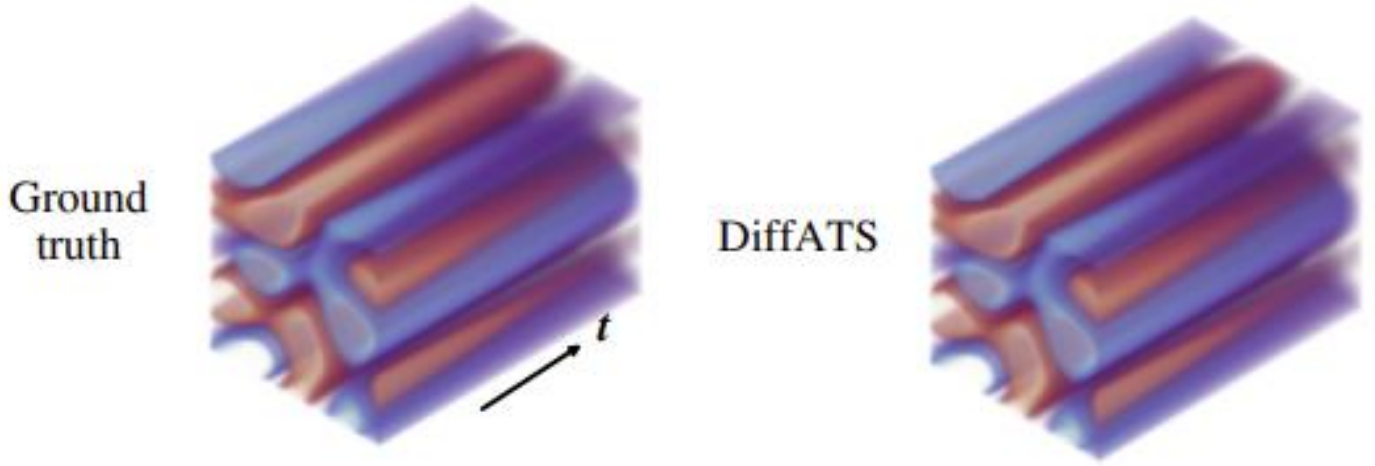
- Scale: ~10 mm
- GPU Memory: ~10 GB
- Time: ~ 1 second

Low-Rank Representations

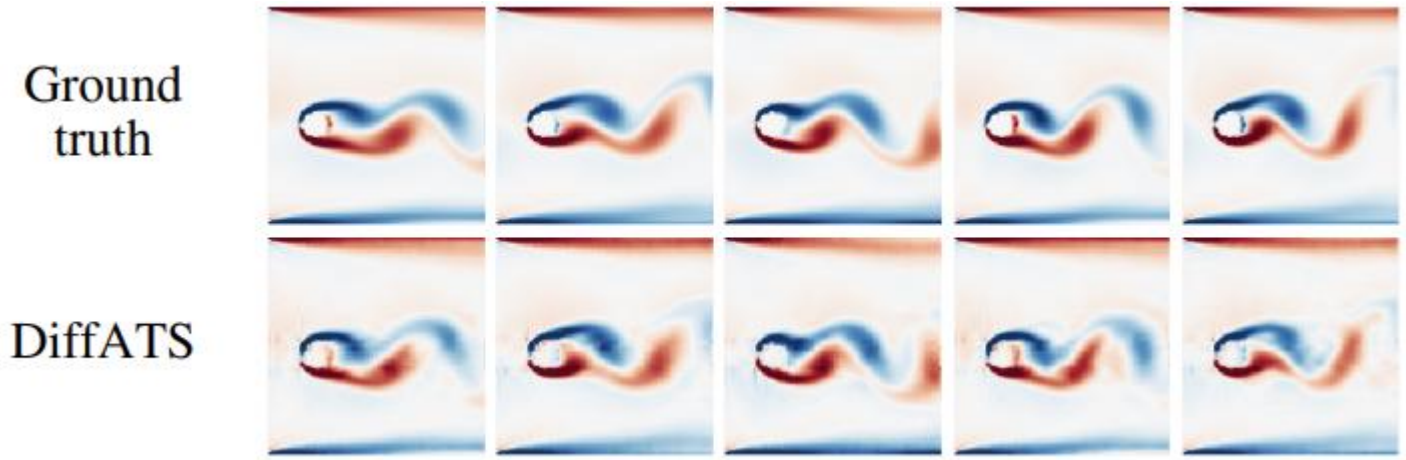


Generative AIs on Low-Rank Representations

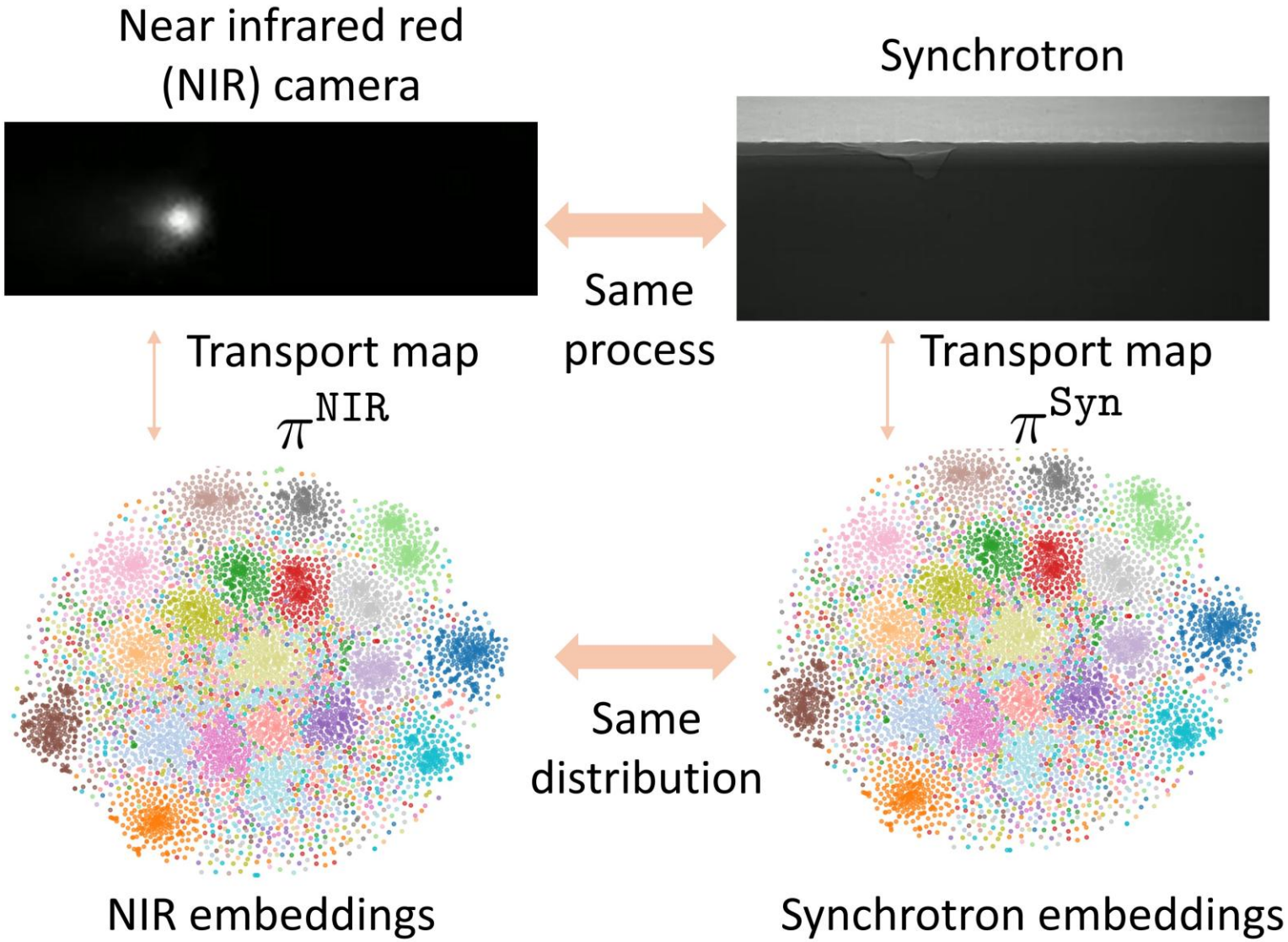
2D Burgers Equation



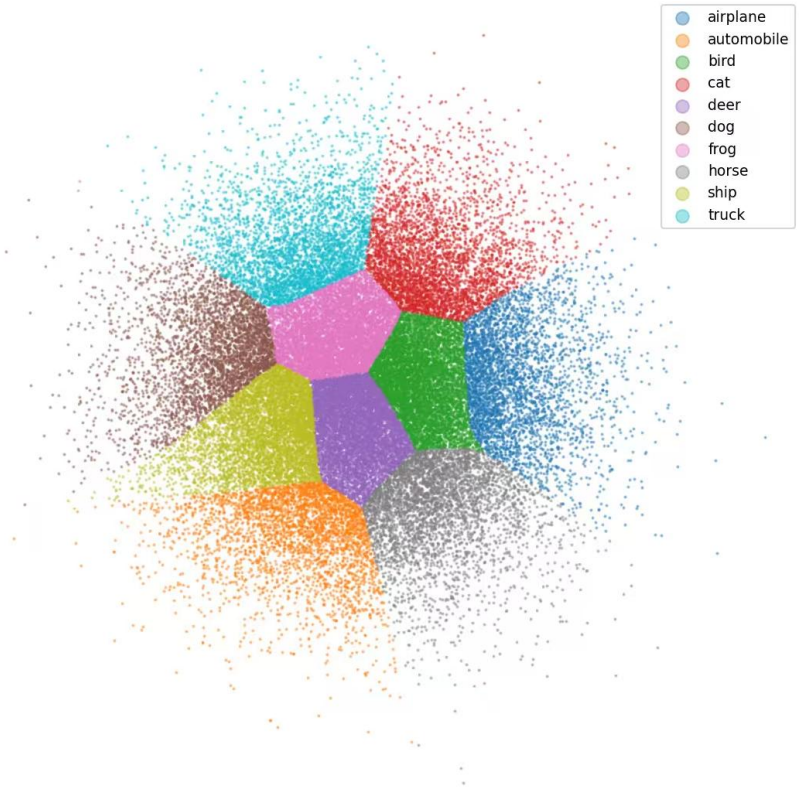
Kármán Vortex Street

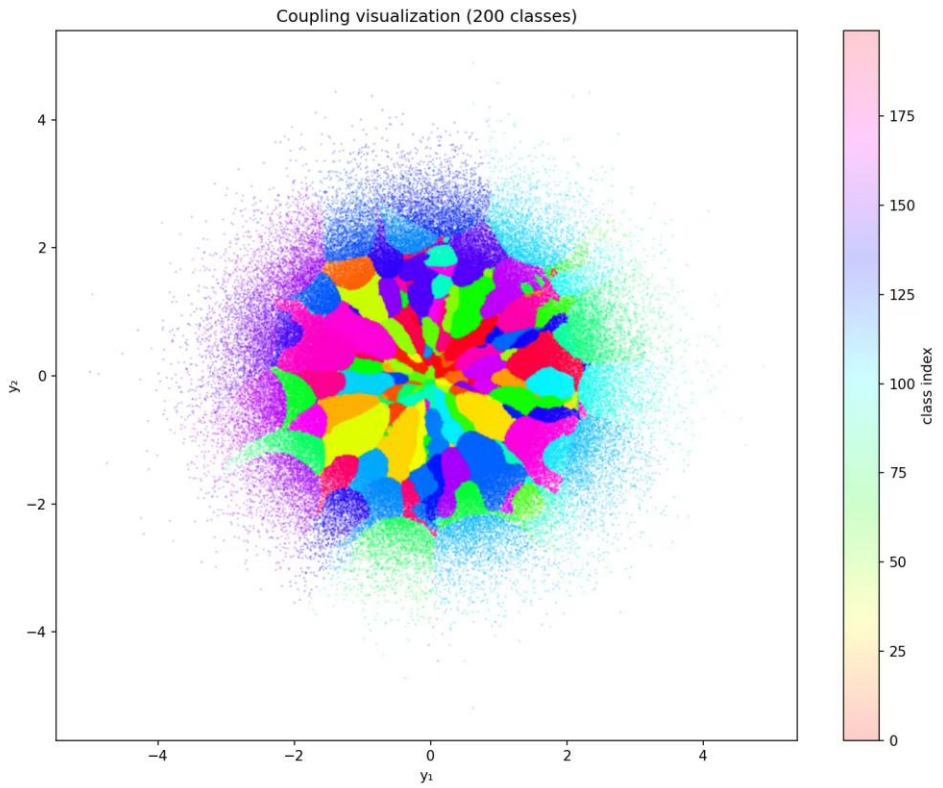


Different Sensors, Same Process, Same Distribution



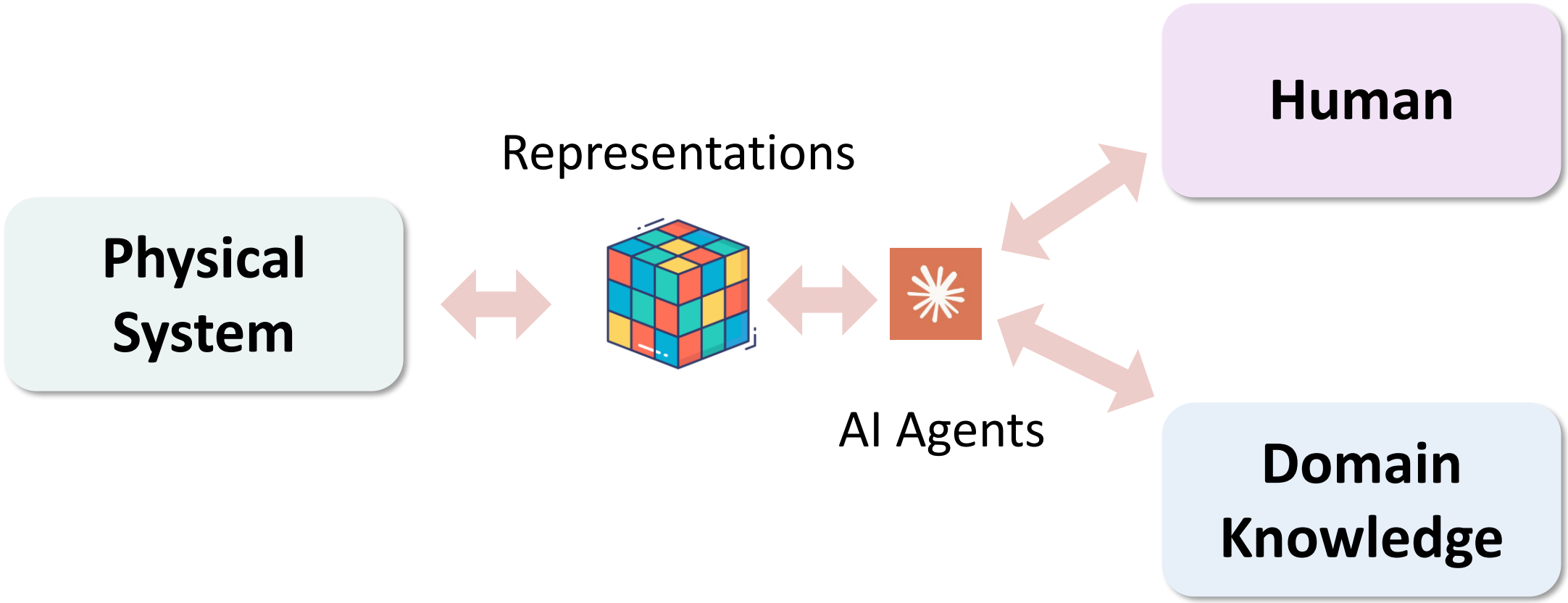
Representation Learning via Optimal Transport





Over 50,000 samples

AI For Monitoring, Reasoning, and Control



Thank You!

Low-rank representation

Optimal transport representation