

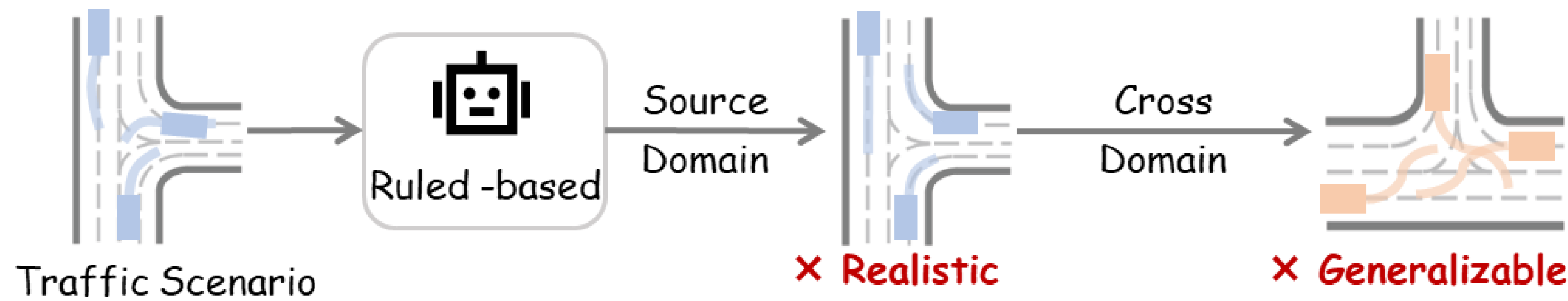
Transferring Causal Driving Patterns for Generalizable Traffic Simulation with Diffusion-Based Distillation

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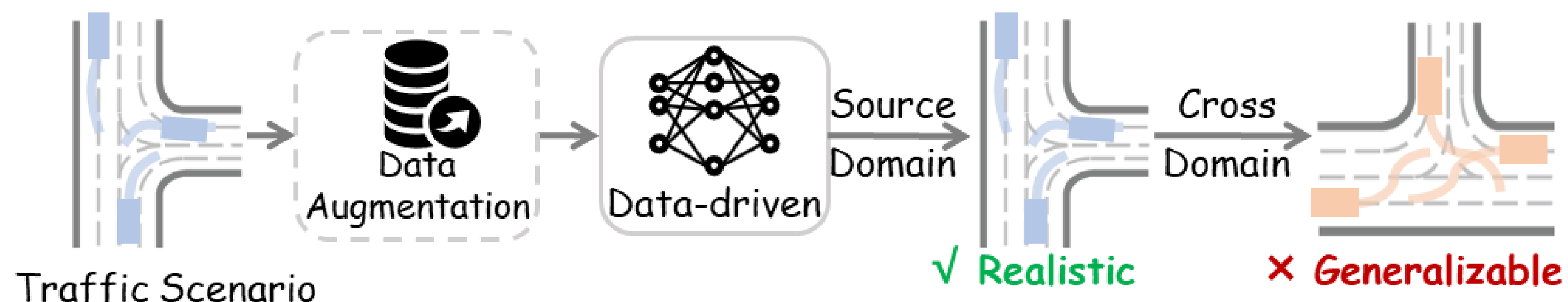
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Challenges

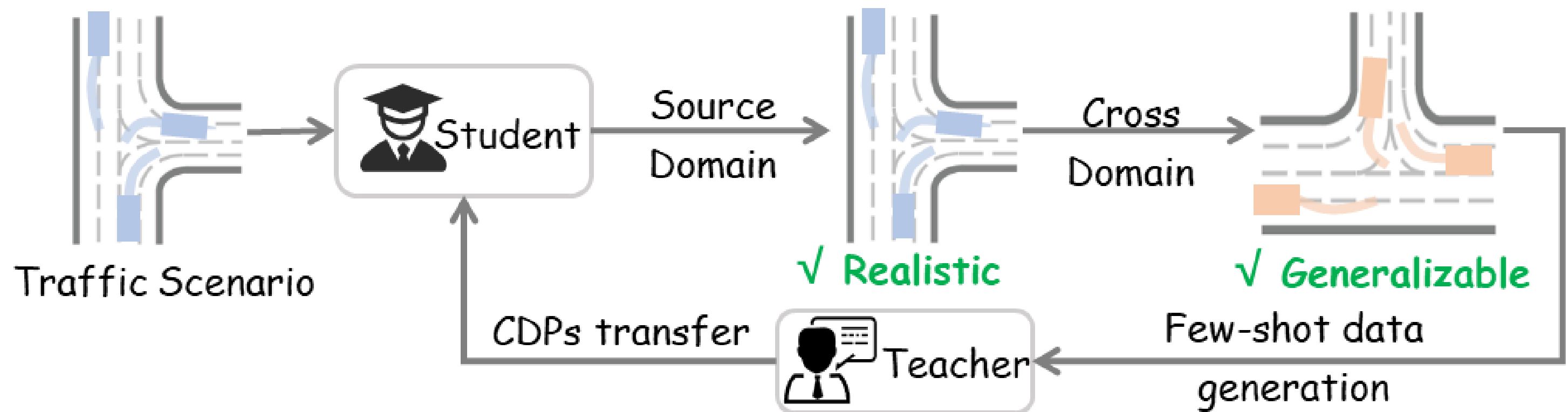
- Existing traffic simulation methods **lack generalization**: overfit and underperform cross-domain, and existing knowledge distillation neglects scene-level multi-agent generalization.



(a) Pipeline of Rule-based Traffic Simulation

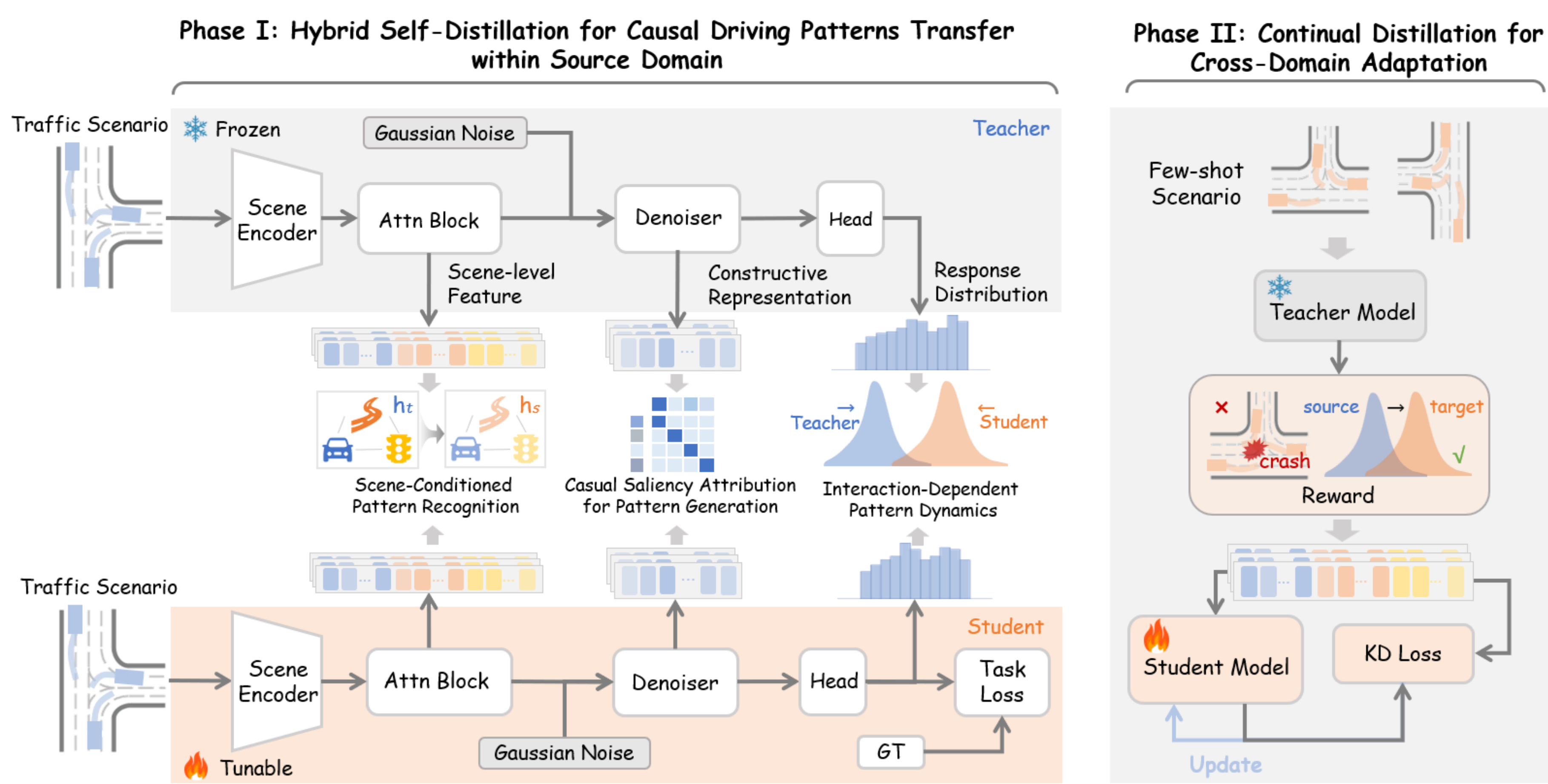


(b) Pipeline of Date-driven Traffic Simulation



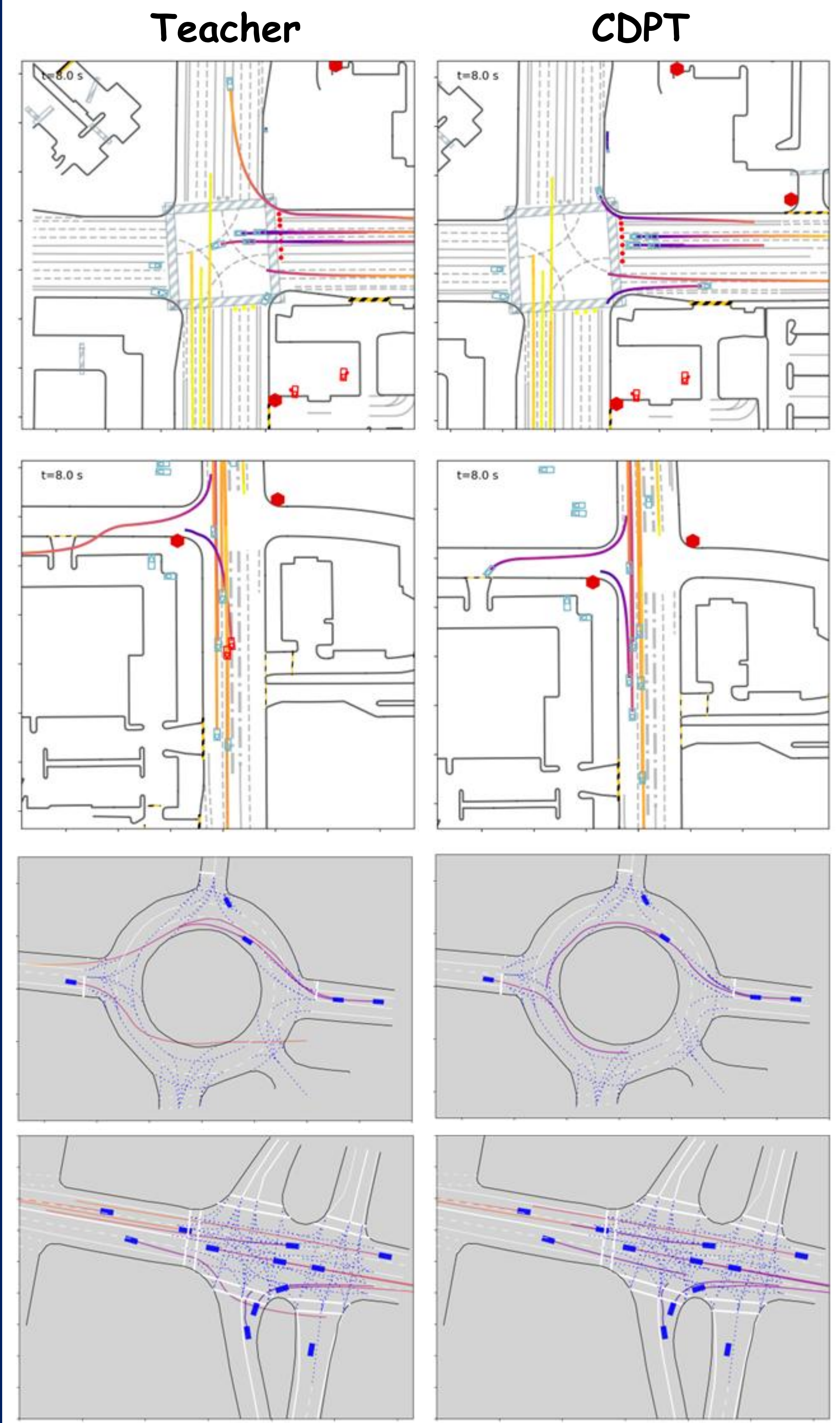
(c) Pipeline of Proposed CDPT in Traffic Simulation

Methodology

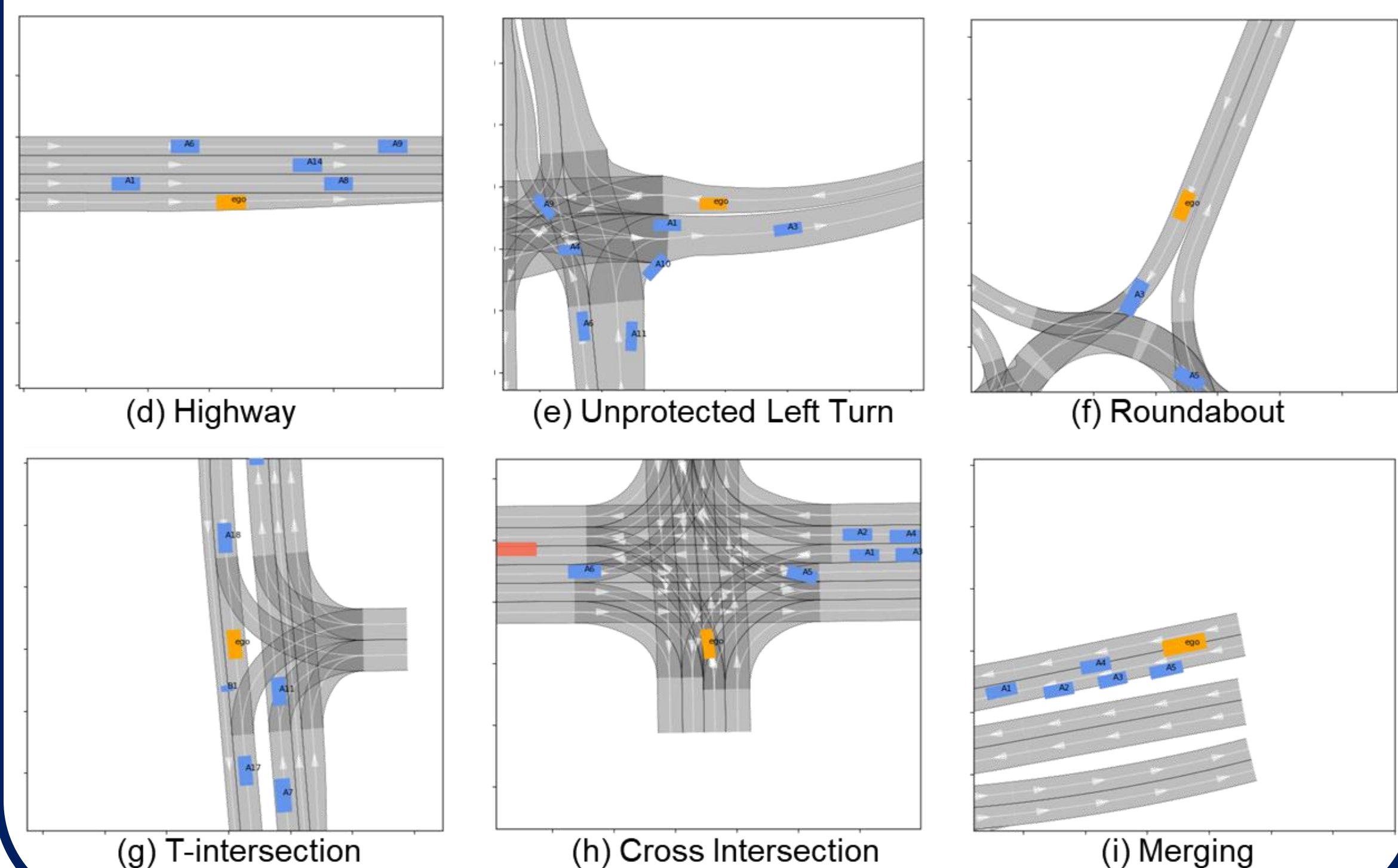


- We propose **CDPT**, a **two-stage diffusion-based KD framework**
- it extracts transferable causal driving patterns via hybrid self-distillation to improve source-domain performance, and uses continual distillation with few-shot target data for cross-domain adaptation, enhancing multi-agent simulation fidelity and generalization.

Experiments



ON SITE Challenge 2025 Testing Performance



Results

- CDPT **achieves the best overall performance against strong baselines**, particularly in collision, off-road, and log divergence metrics across Phase I/II, with the **lowest** collision rates and log divergences, plus competitive kinematic infeasibility results.
- CDPT shows enhanced **compliance, stability, and safety** in diverse interactive scenarios, highlighting its superior zero-shot generalization for safe, context-aware interactive behaviors.

