

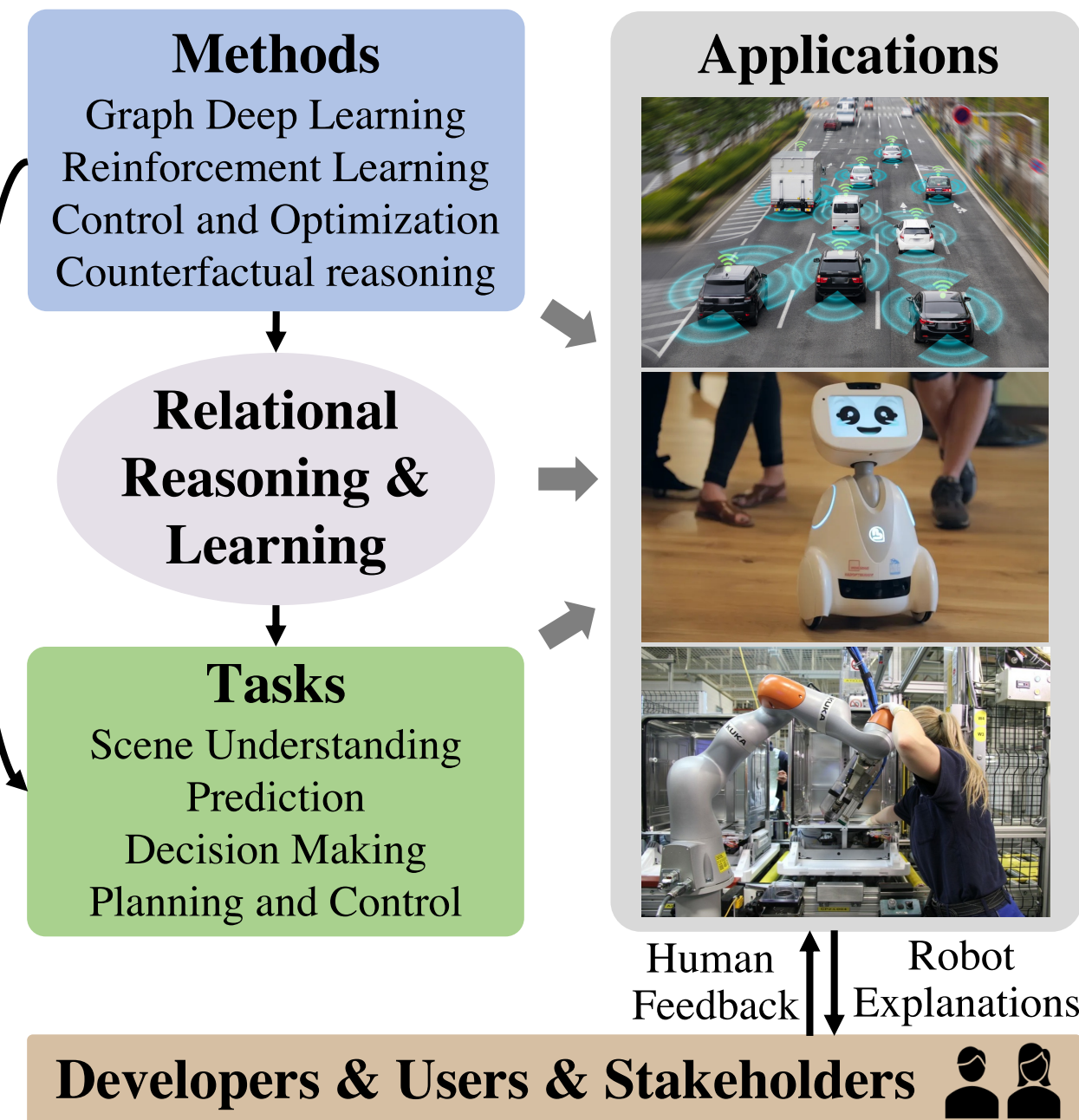
# Toward Trustworthy Interactive Autonomy with Relational Reasoning



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## Research Overview

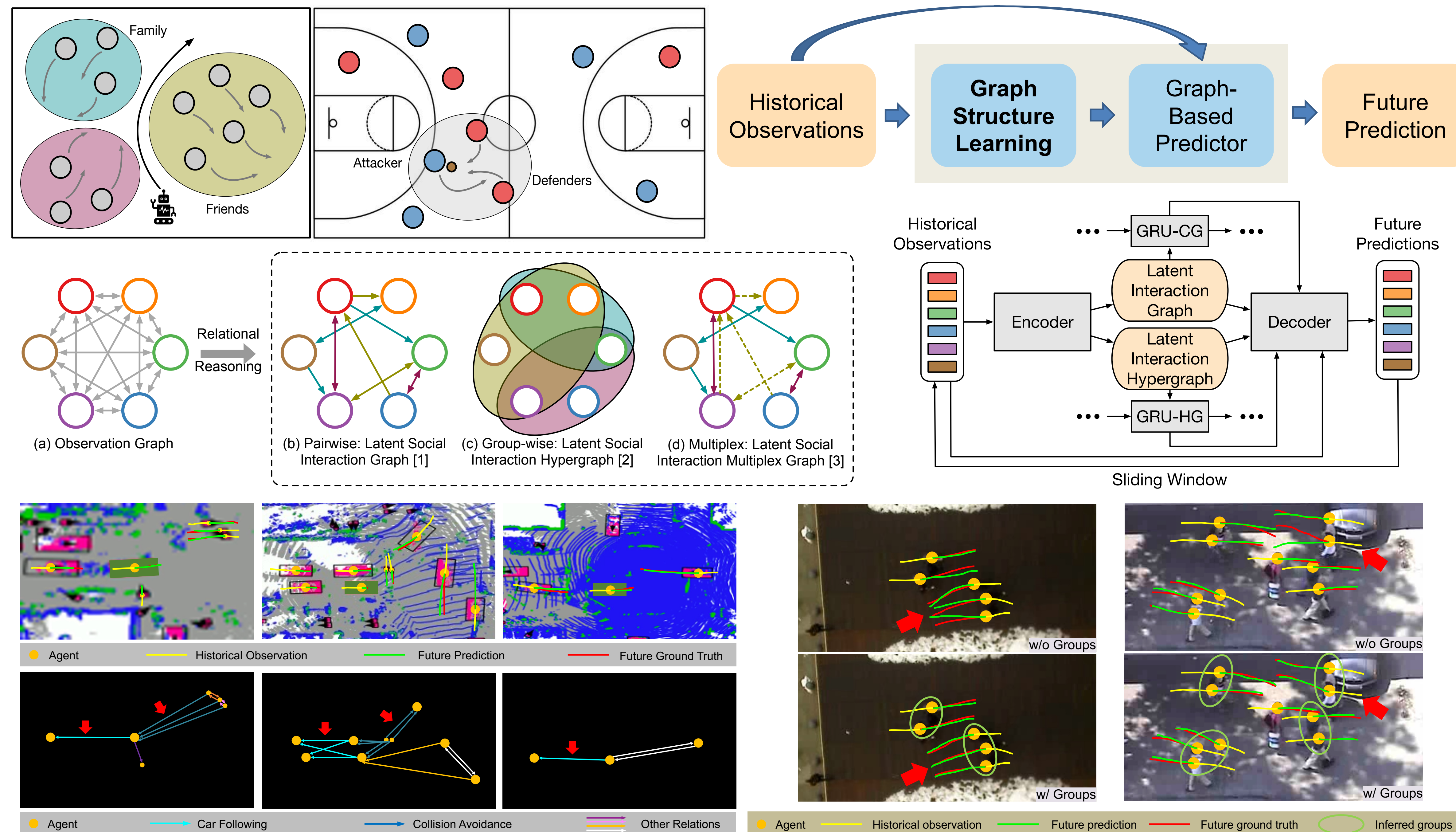


Relational Reasoning  
Interaction Modeling

Trustworthy  
Transparent  
Human-Centered

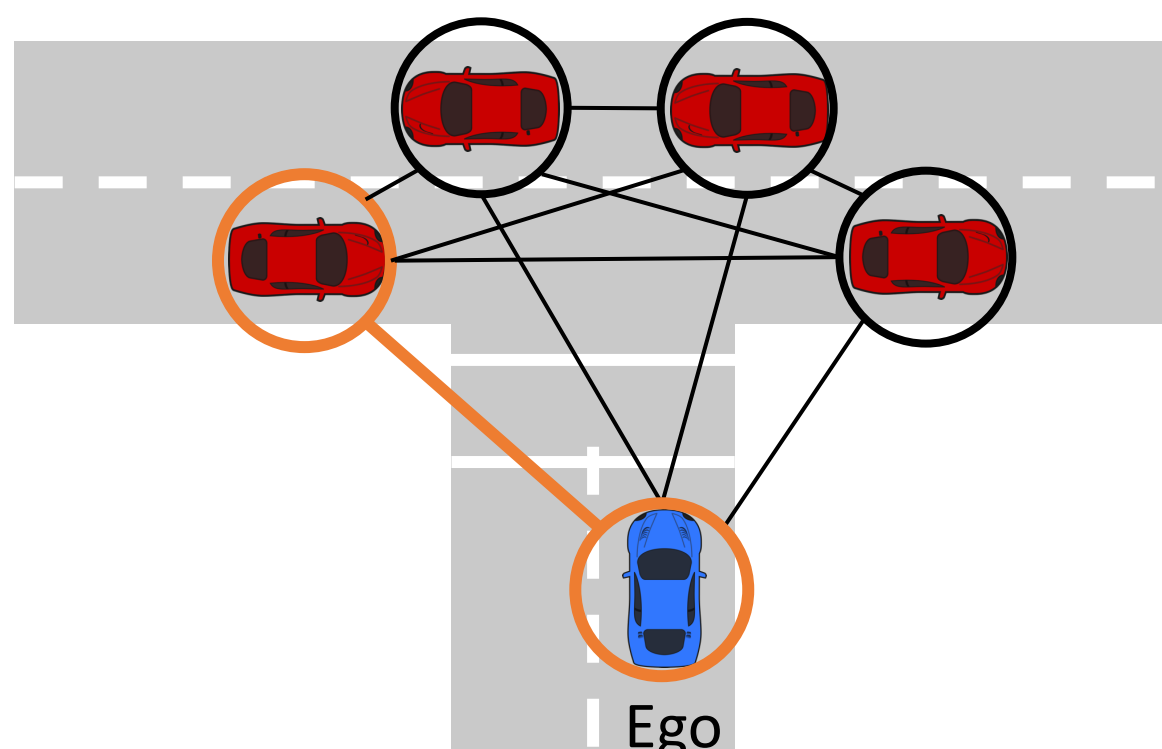
Scalability, Efficiency  
Explainability, Interpretability  
Generalizability, Robustness

## Relational Reasoning: Pairwise, Group-wise, and Multiplex Relations



## Fundamental Research Question

How to model the underlying **social interactions** between agents and exploit the **learned relational representations** in downstream tasks in a principled manner?

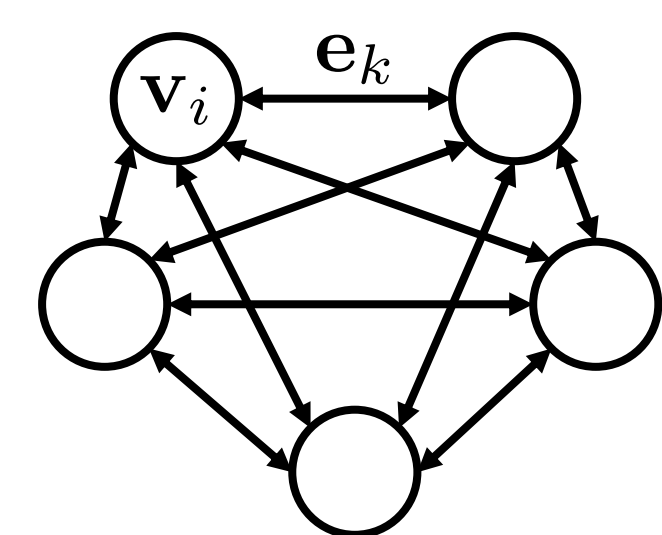


## Relational Reasoning

To identify **pairwise**, **group-wise**, and **multiplex** relations

To explicitly infer the **relation types/patterns** between agents

## Graph Neural Network



Edge attribute  
(e.g., relation feature)

Edge Update  
 $e'_k = \phi^e(e_k, v_i, v_j)$

Node attribute  
(e.g., agent state)

Node Update  
 $v'_i = \phi^v(e'_i, v_i)$

**Scalability:** shared node/edge functions across the graph  
**Capacity:** arbitrary relations; higher-order interaction modeling  
**Flexibility:** encode visual/language inputs

## References

- [1] J. Li et al, "EvolveGraph: Multi-Agent Trajectory Prediction with Dynamic Relational Reasoning", in *NeurIPS 2020*.
- [2] J. Li et al, "Group-Aware Dynamic Relational Reasoning", under review.
- [3] F. Sun, I. Kauvar, R. Zhang, J. Li, M. J. Kochenderfer, J. Wu, and N. Haber, "Interaction Modeling with Multiplex Attention", in *NeurIPS 2022*.
- [4] X. Ma, J. Li et al, "Reinforcement Learning for Autonomous Driving with Latent State Inference and Spatial-Temporal Relationships", *ICRA 2021*.
- [5] J. Li et al, "Explainable Autonomous Navigation with Internal State Inference and Interactivity Estimation", submitted to *IEEE Transactions on Robotics*.

## Explainable Autonomous Navigation with Deep Reinforcement Learning

