Trust Topologies in Verification of Social Explainable AI

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ATL: What Agents Can Achieve

- ATL: Alternating-time Temporal Logic [Alur et al. 1997-2002]
- Temporal logic meets game theory
- Main idea: cooperation modalities

$\langle\langle A \rangle\rangle \Phi$: coalition A has a collective strategy to enforce Φ

$\rightsquigarrow$ Φ can include temporal operators: X (next), F (sometime in the future), G (always in the future), U (strong until)

Semantic Variants of ATL

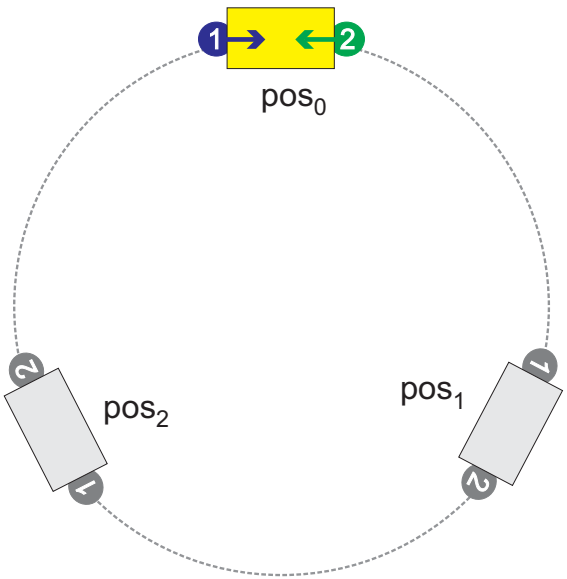
Memory of agents:

- Perfect recall (R) vs. imperfect recall strategies (r)

Available information:

- Perfect information (I) vs. imperfect information strategies (i)

Example: Robots and Carriage



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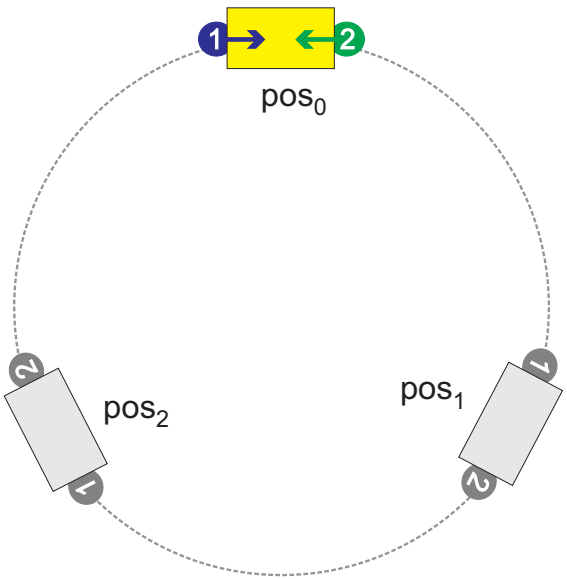

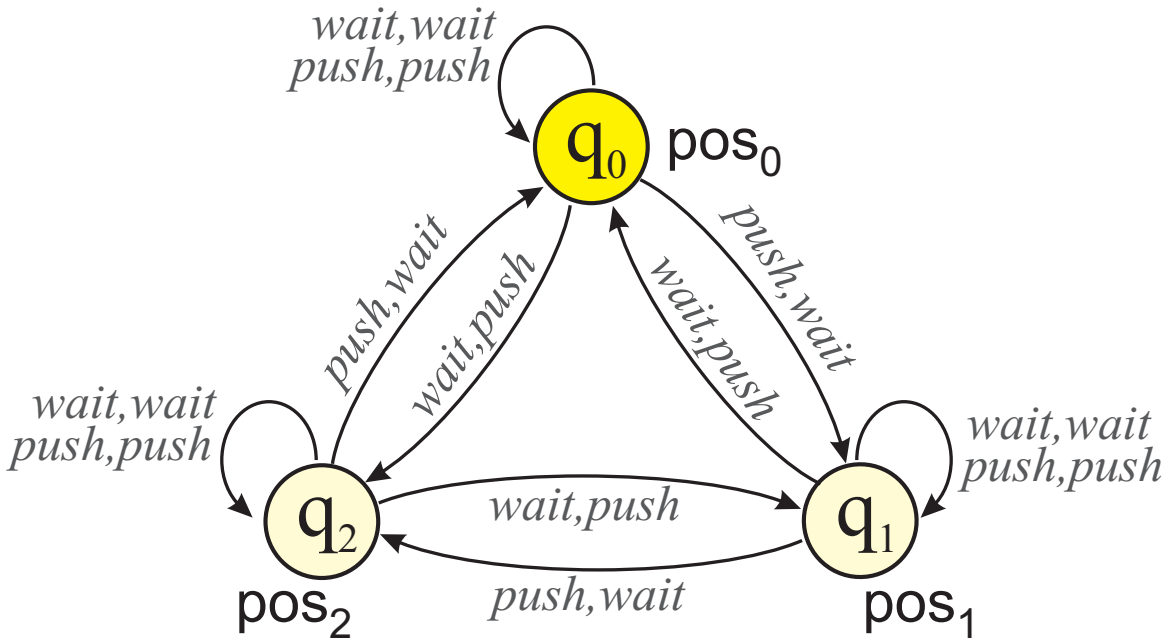

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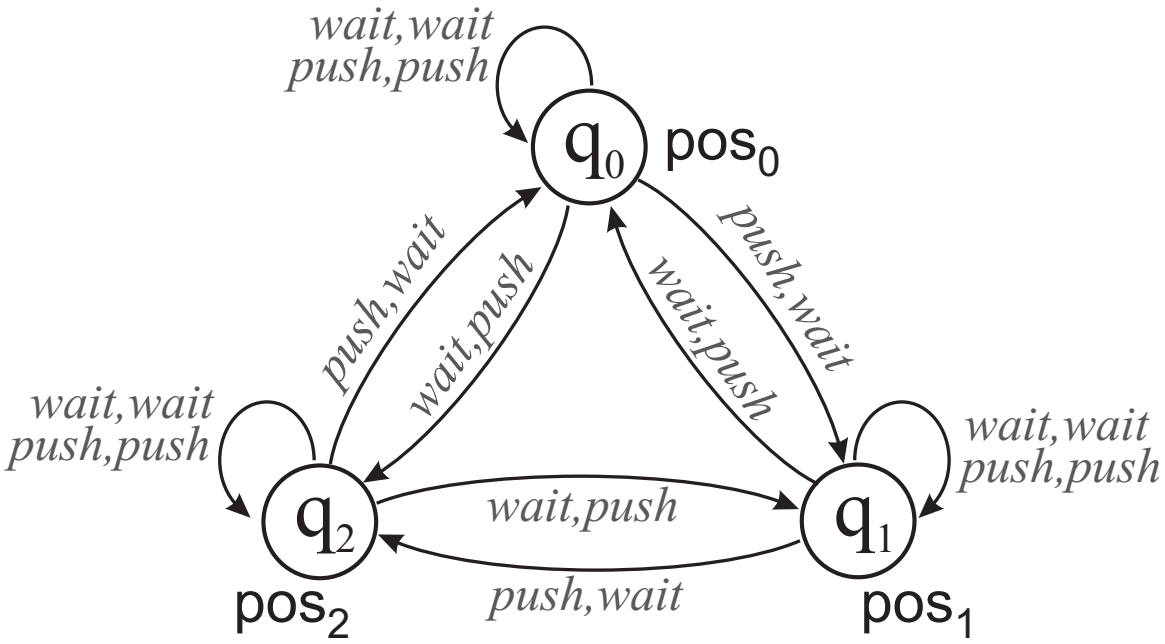

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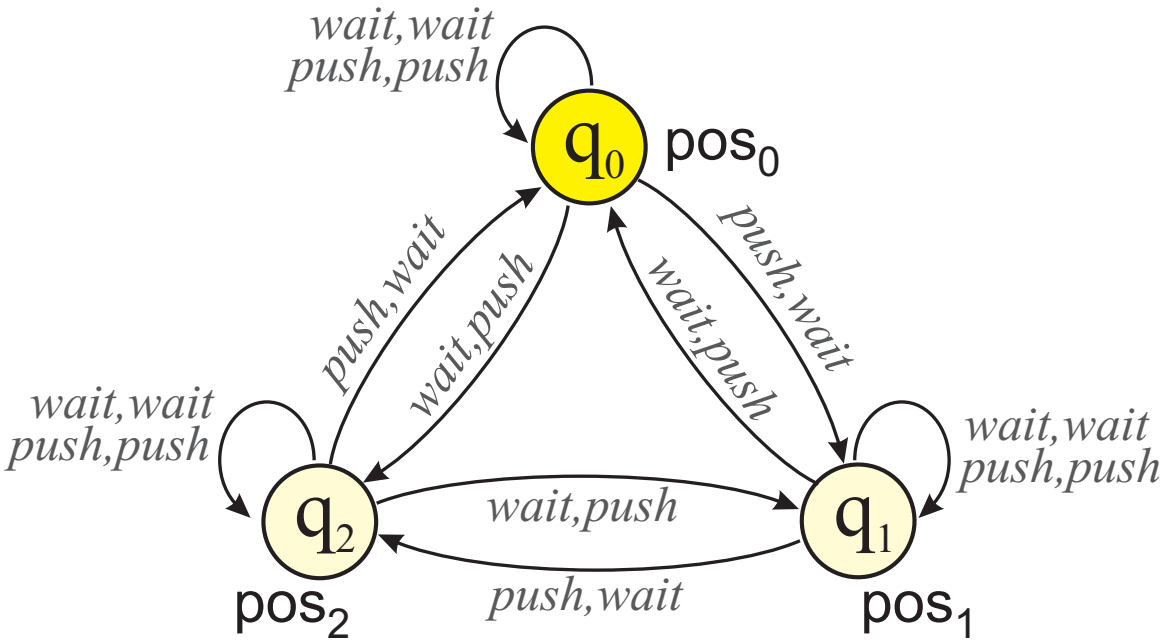

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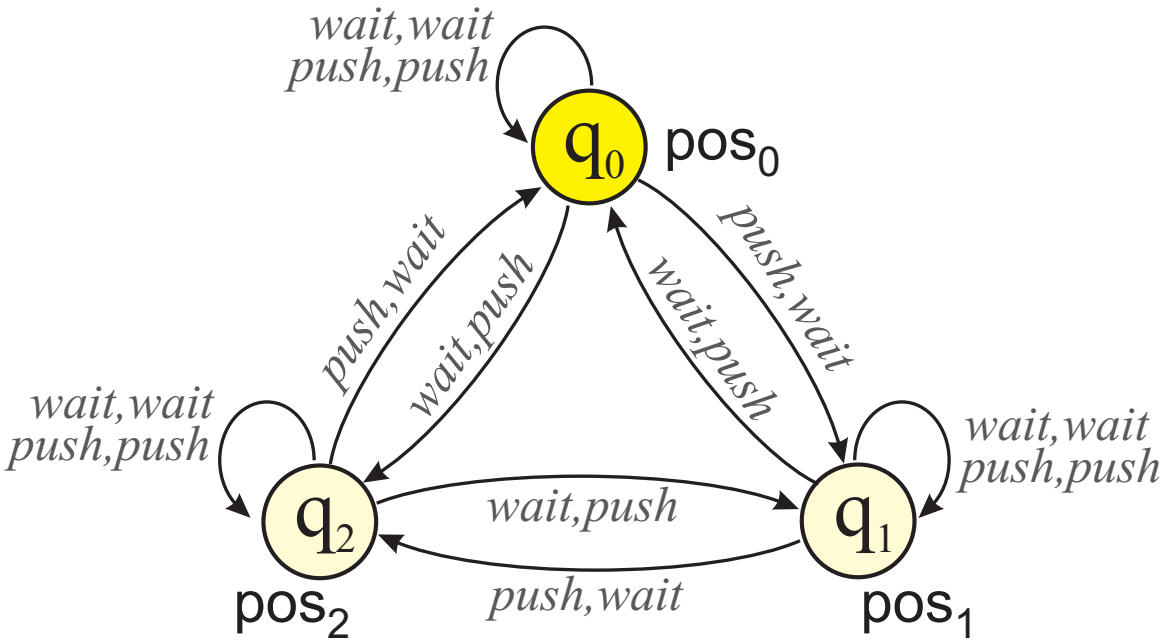

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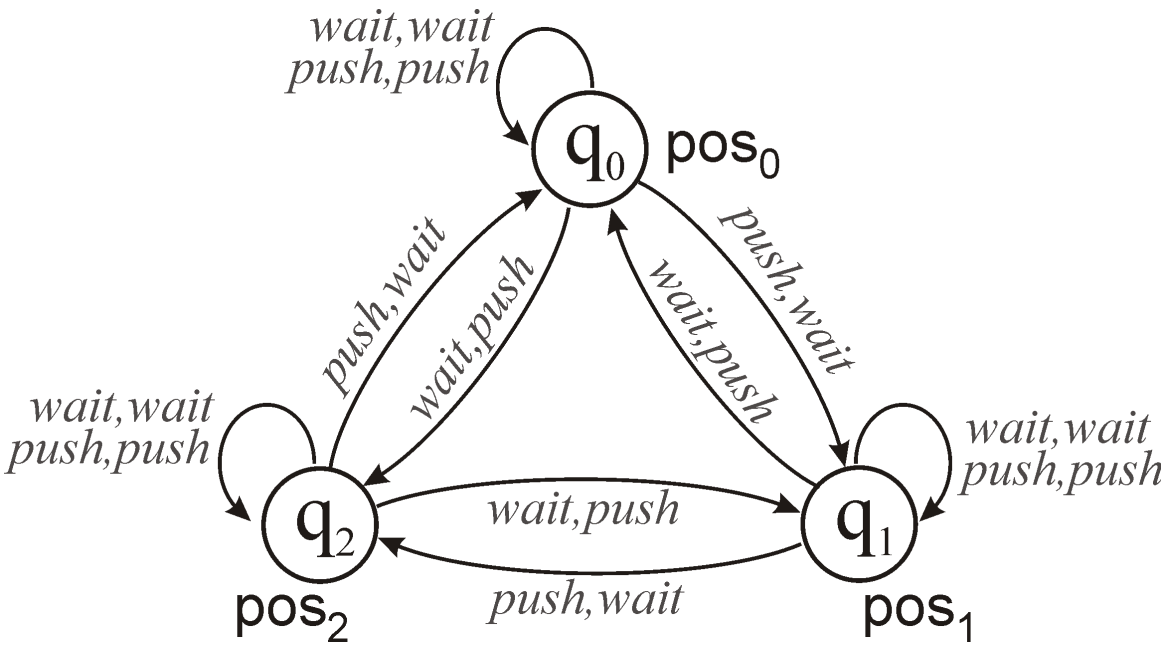

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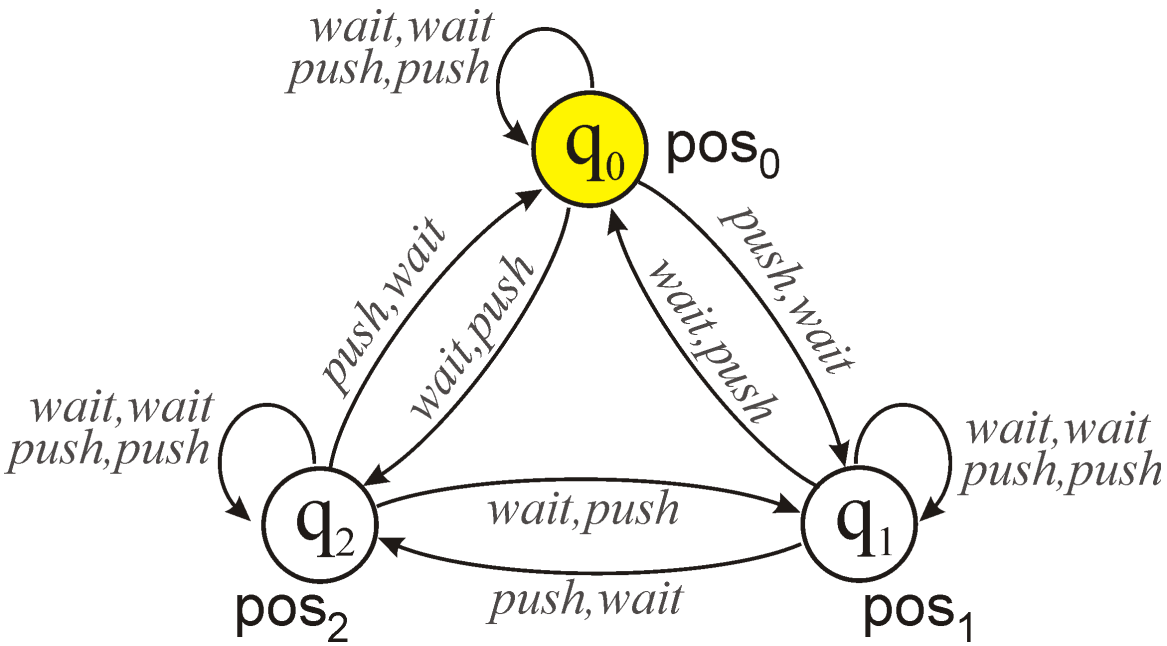

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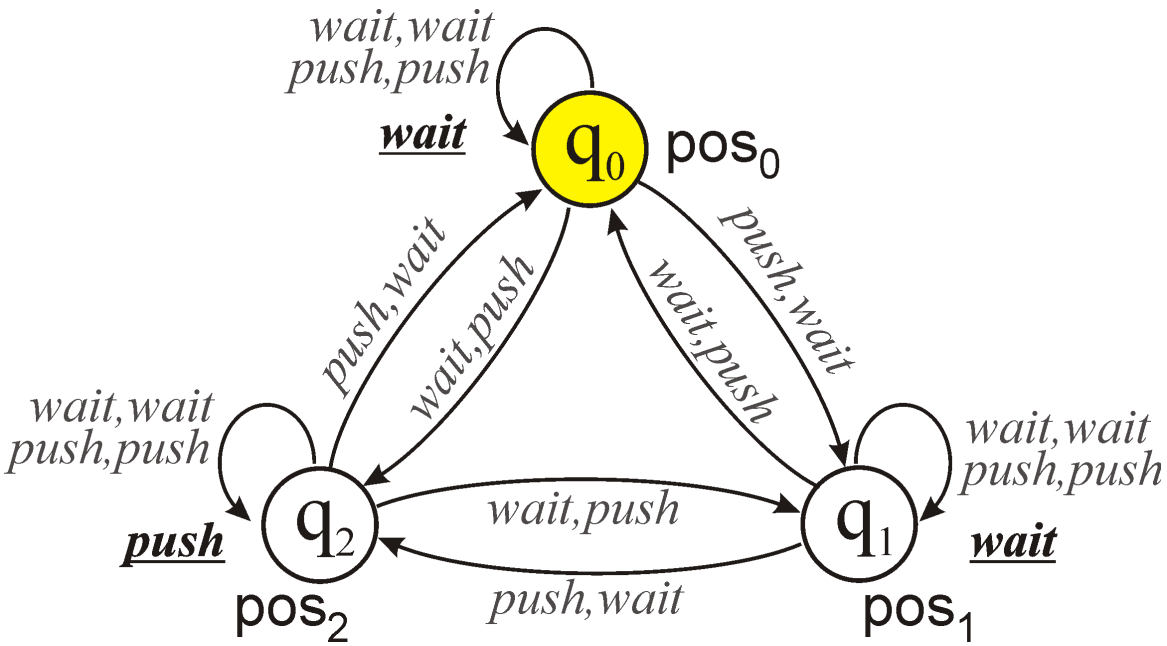

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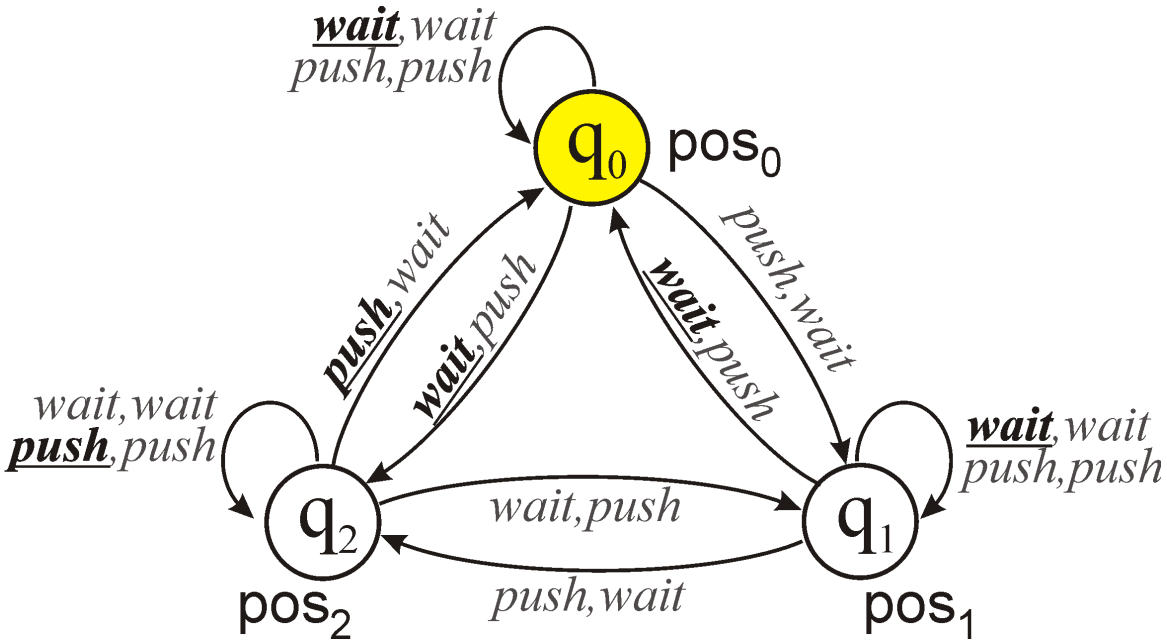

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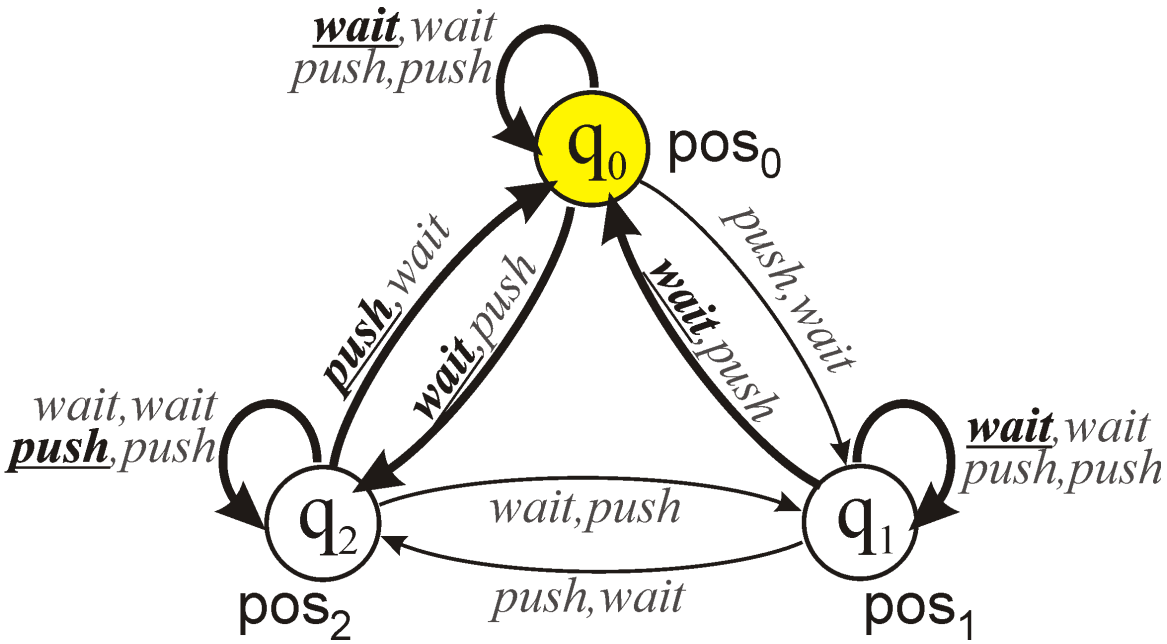

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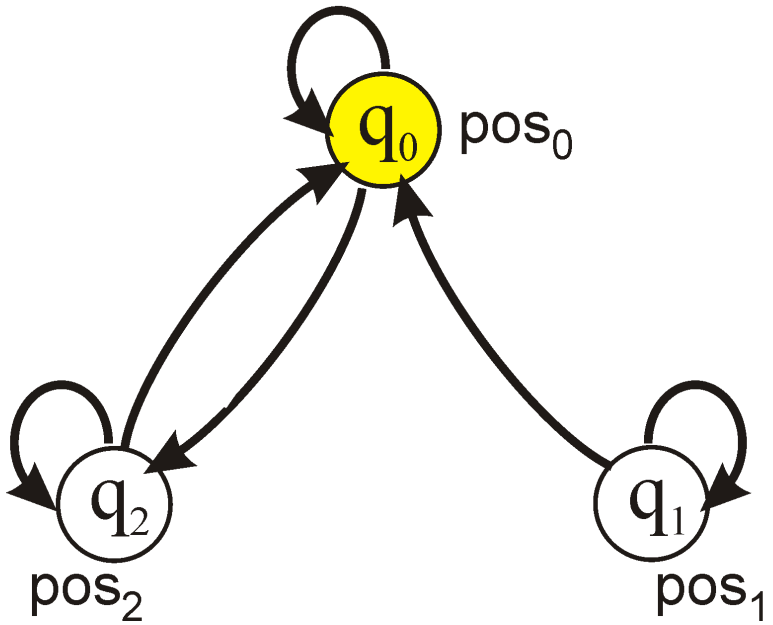

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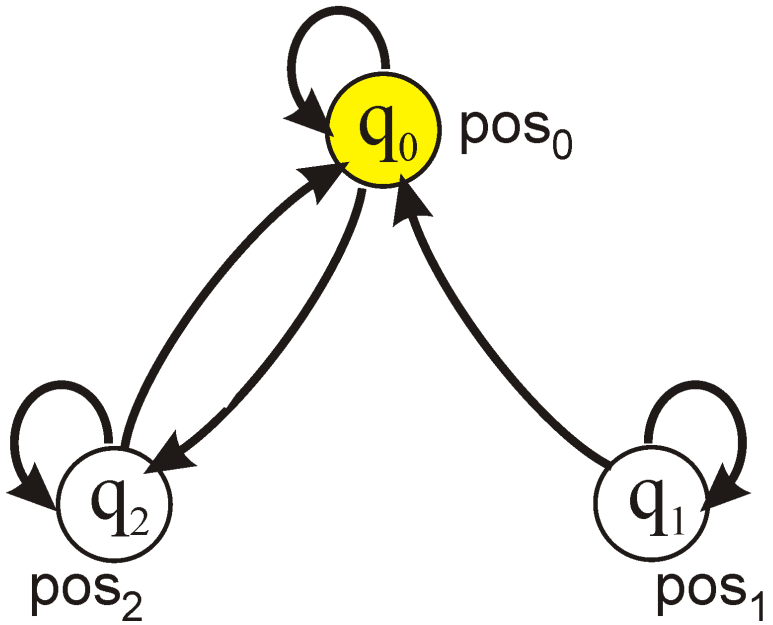

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- Model checking $\mathbf{ATL}_{\mathrm{ir}}$ is Δ_2^p-complete

SAI

- A novel approach in AI focusing on decentralization and transparency.
- Emphasizes the social context and human-centricity in AI applications.
- Aims to overcome the black-box nature of traditional AI systems.
- Moving from centralized control to **individualized AI entities** that interact with each other.
- Incorporating explainability by design, fostering trust and understanding in AI systems.

Formal Modelling of SAI

Multi-Agent Systems (MAS)

Networks of agents that interact with each other to achieve certain goals.

Asynchronous Multi-Agent Systems (AMAS)

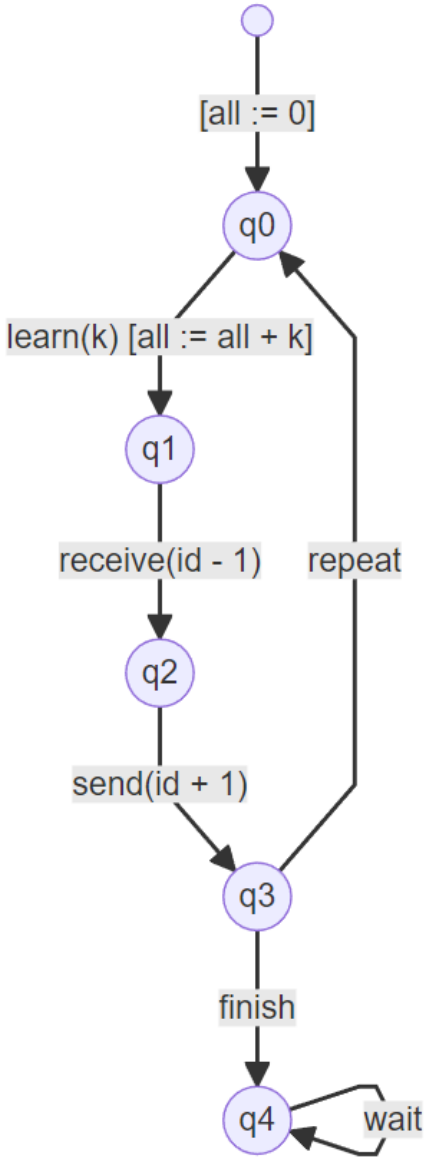
A type of MAS where agents operate and interact asynchronously, allowing for more complex and realistic modeling of systems.

- Utilizing AMAS to **model the network of Personal AI Valets** (PAIVs) and **formalize their properties** using logical frameworks.
- Modeling the network of PAIVs as an AMAS to capture the dynamics of decentralized, interactive, and explainable AI environments.

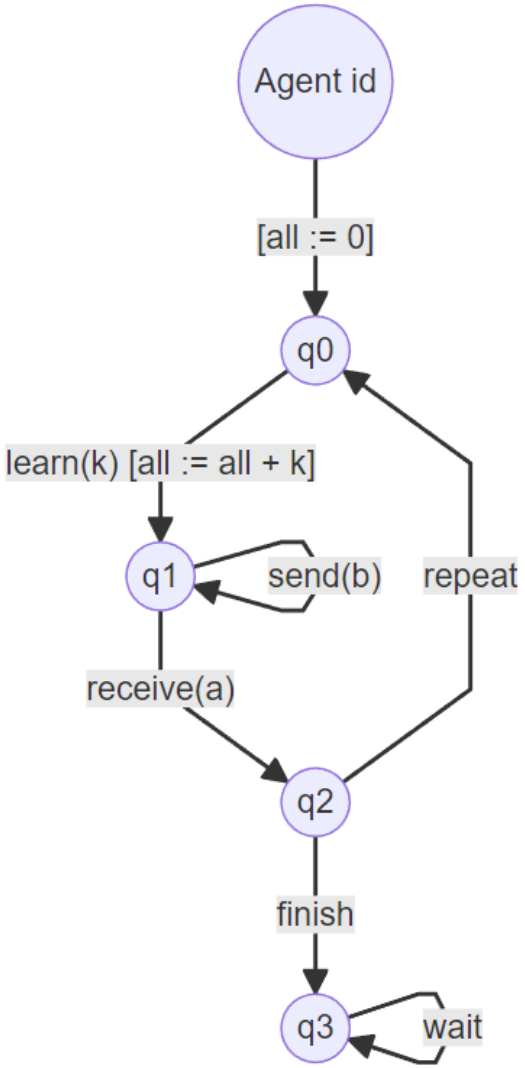
Modelling Agents

- Each agent represents a PAIV
- Focus on sharing phase to facilitate interaction and collaboration among agents.
- Sharing: the phase where the agent shares its findings and collaborates with other agents in the network.
- Order of interactions between agents based on the underlying network-like topology.
- Using **trust topologies** to define trust relationships between agents.

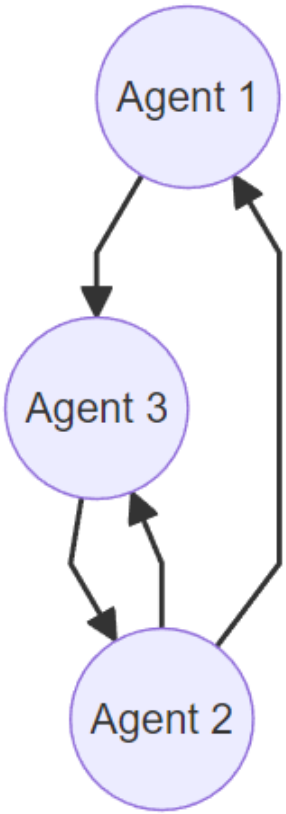
Example: Ring Topology



Example: Universal Template



Example: Trust Topology (3 Agents)



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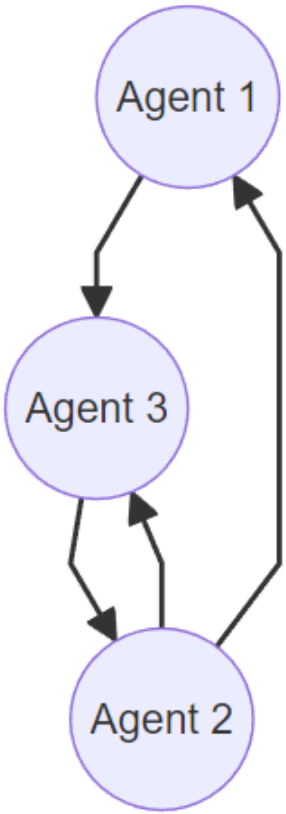

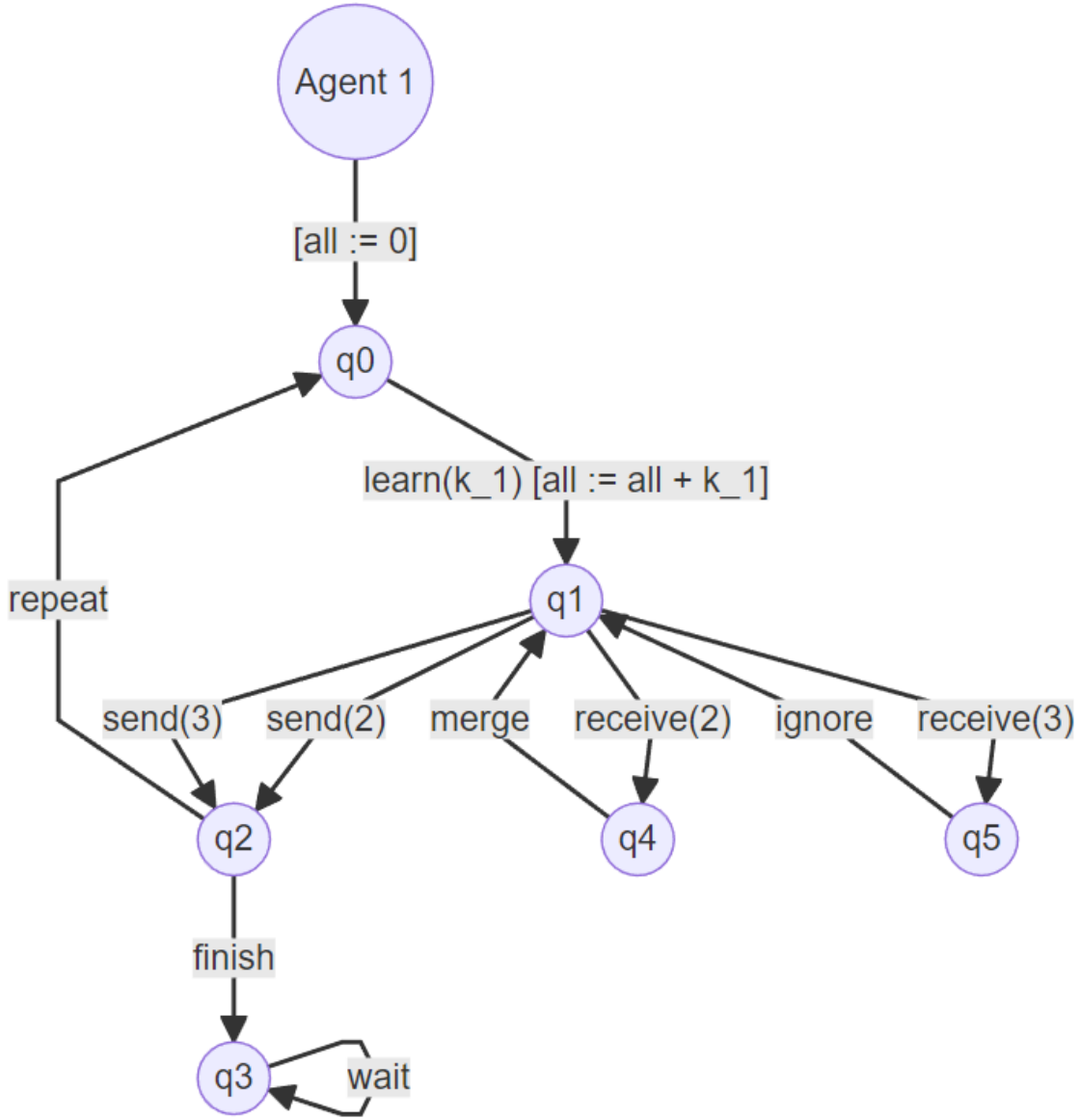

Attack Scenarios

Man in the Middle

- Engages actively during the sharing phase.
- Has the ability to intercept any model being transmitted by one of the honest agents and subsequently relay it to another agent.

Impersonator

- Involves an AI agent being compromised with malicious code, leading to undesirable behavior.
- Adheres to the sharing protocol when disseminating its model to others.
- Possesses the capability to falsify the quality of its local AI model, thereby deceiving the subsequent agent into accepting it.

Our Goals

- Specify and implement models of Social Explainable AI (SAI) protocol, with a focus on the sharing phase.
- Define essential properties of these models, specify them in Alternating-time Temporal Logic with Imperfect Recall (**ATL**$_{\text{ir}}$), and verify them using our specialized model-checker.
- Explore how different trust topologies and sharing protocols can enhance transparency and user trust in SAI systems.
- Develop simulation environments to evaluate the effectiveness of the SAI protocol in various contexts.

Damian Kurpiewski, Wojciech Jamroga, Teofil Sidoruk:
Towards Modelling and Verification of Social Explainable AI.
ICAART 2023: 396-403

Thank You