Causal Explanations for Sequential Decision-Making in Multi-Agent Systems

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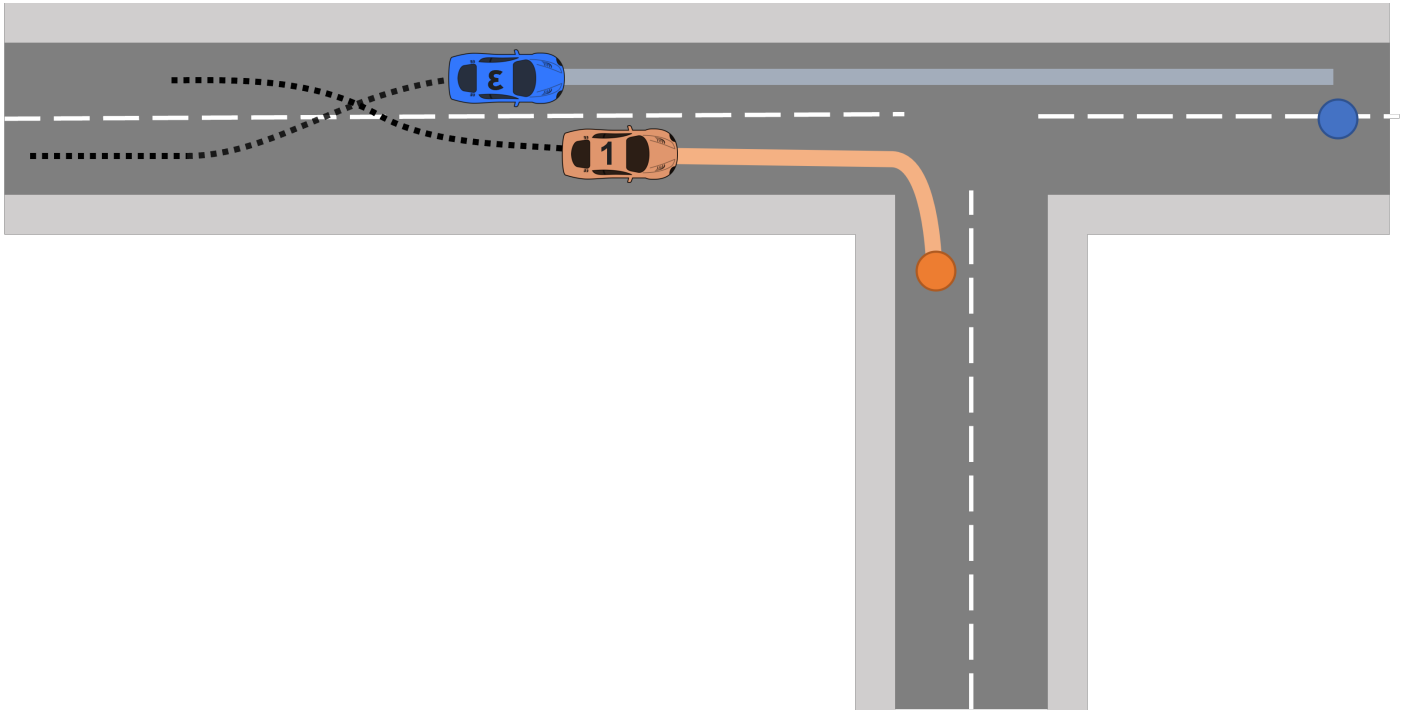
In IJCAI 2023 Workshop on Explainable Artificial Intelligence

- Example domain: autonomous driving;
- Many agents, coupled interactions, difficult to explain;
- Safety-critical environment: explanations (hopefully) build trust and understandability.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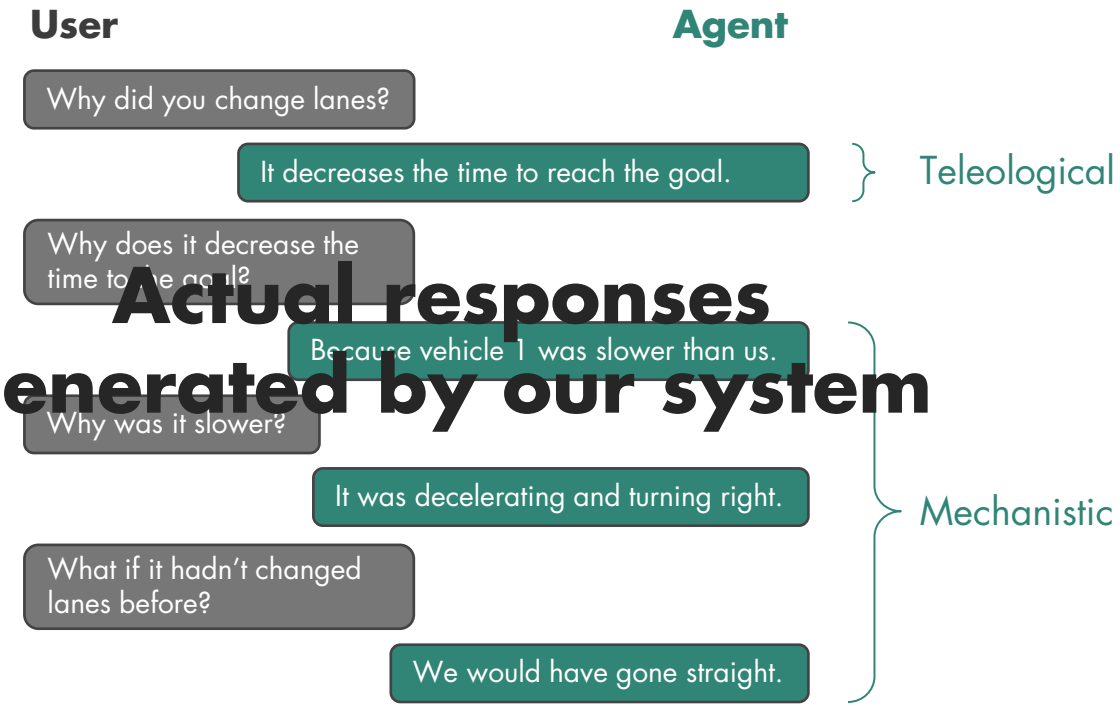


Actual responses generated by our system

CEMA:

Causal Explanations in Multi-Agent system

CEMA

- Applicable if you have:
  - Probabilistic model to predict subsequent states;
  - No need to assume causal structure.
- Contrastive, causal, selected explanations.
- Designed for interactive explanations.

CEMA

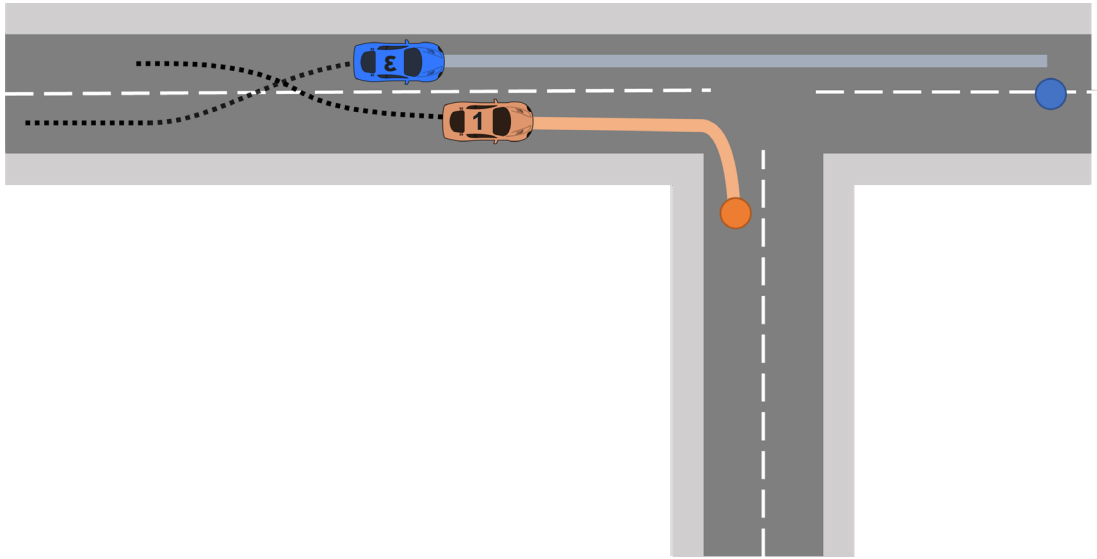
Rollback → Sample → Calculate

Counterfactual Effect Size Model

Tadeg Quillien and Christopher G Lucas, "Counterfactuals and the logic of causal selection"; *Psychological Review,* 130, 2023.

CEMA

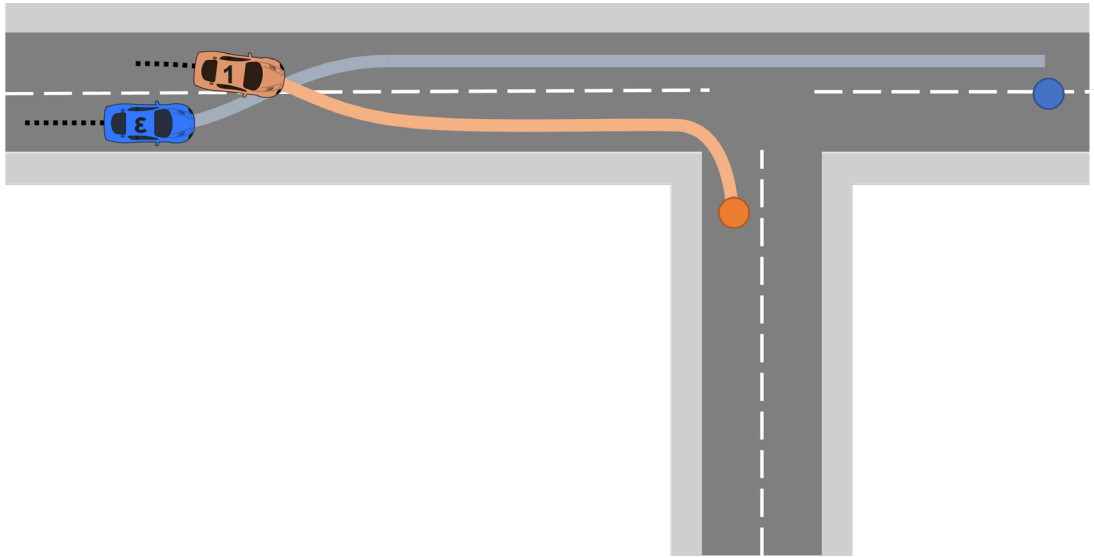
Rollback!



Rollback → Sample → Calculate

CEMA

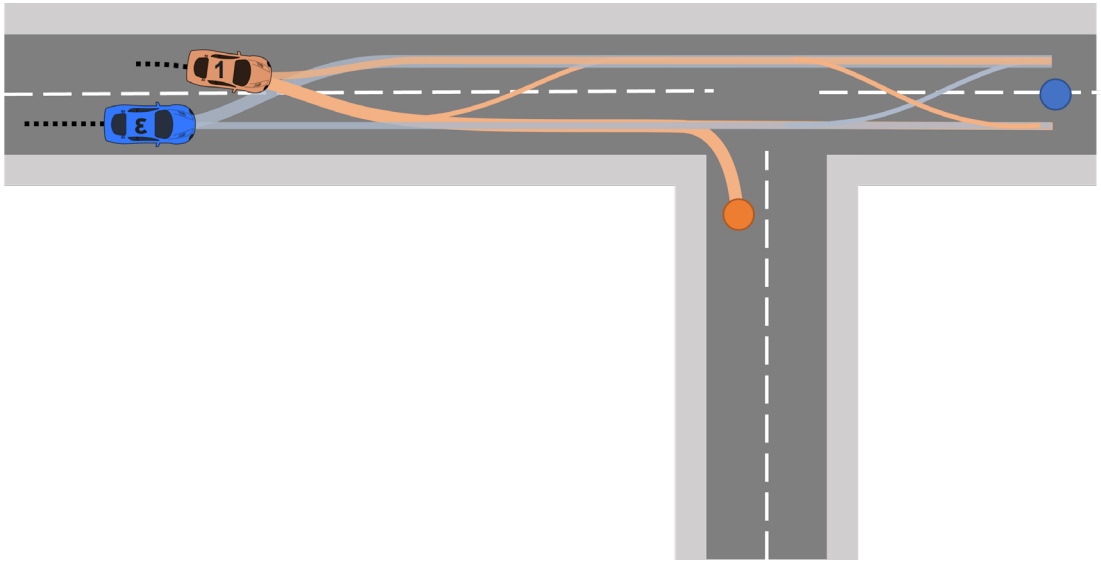
Rollback!



Rollback → Sample → Calculate

CEMA

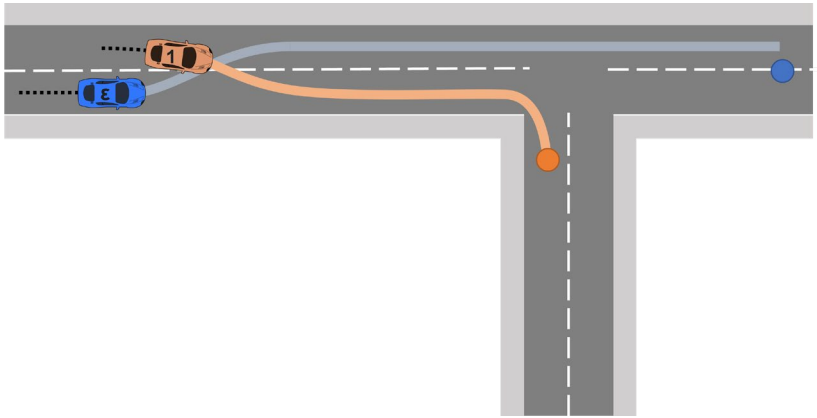
Sample!



Rollback → Sample → Calculate

CEMA

Sample!



Action presence:
Lane change (1)

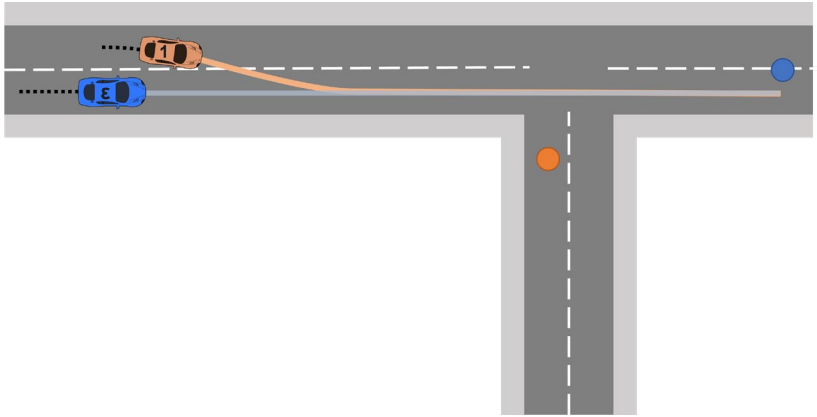
Intrinsic rewards:
Time-to-goal: 5 s
Jerk: 0.2 m/s^3
Collision: No

Features (binary):
{Decelerate, Turn, Slower, etc…}

Rollback → Sample → Calculate

CEMA

Sample!



Action presence:
No lane change (0)

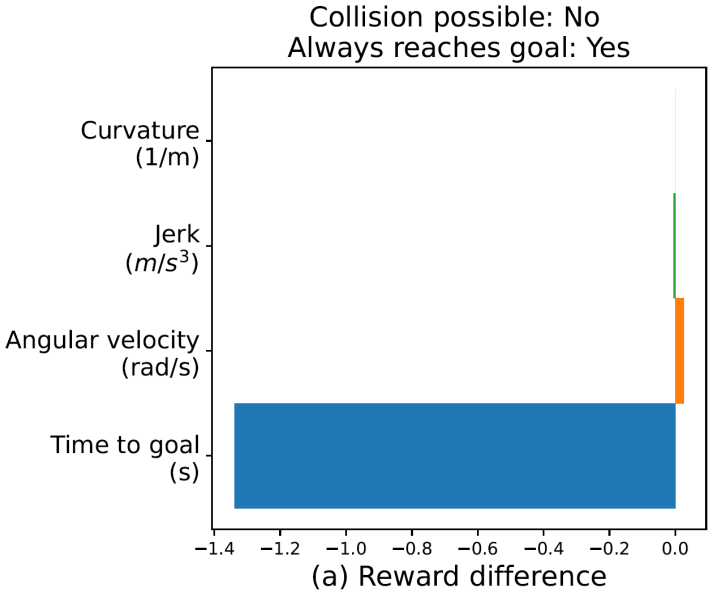
Intrinsic rewards:
Time-to-goal: 10 s
Jerk: 0.7 m/s^3
Collision: No

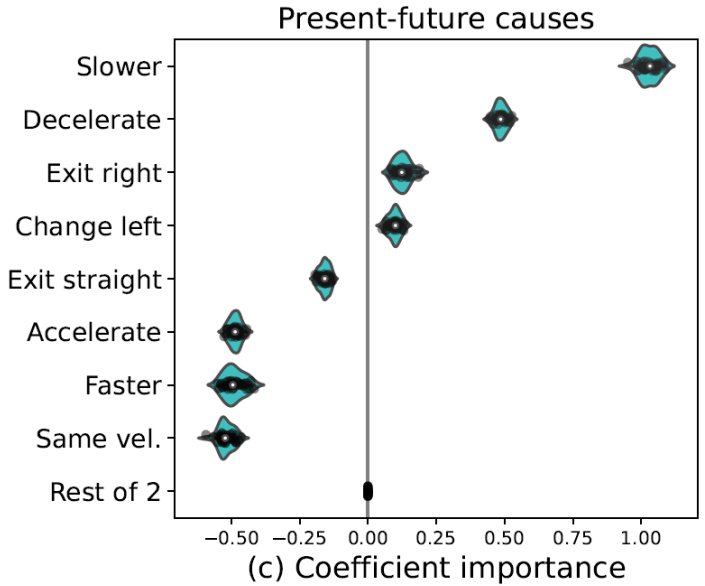
Features (binary):
{Accelerate, Continue, Faster, etc…}

Rollback → Sample → Calculate

CEMA

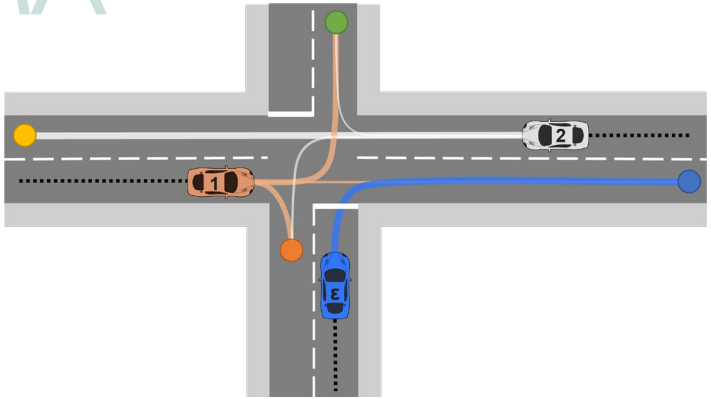
Calculate!

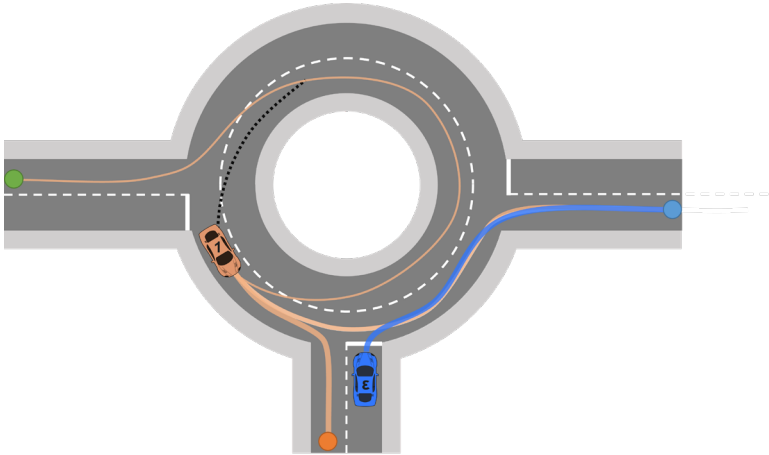


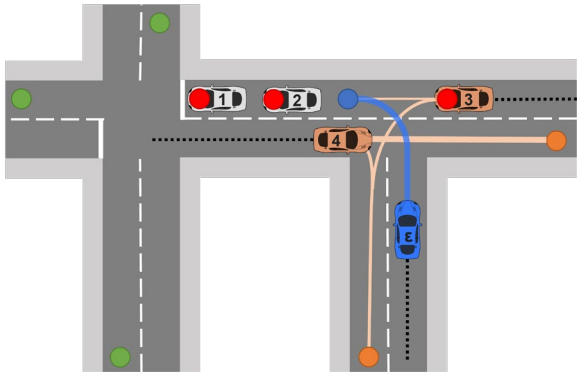


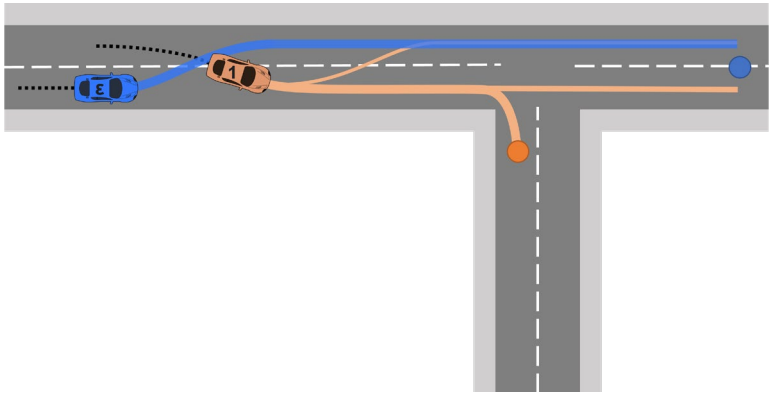
Rollback → Sample → Calculate

CEMA









- Works for large number of agents:
  - Tested with up to 20 agents;
- Two-stage human evaluation for goodness of explanations:
  - Compared against human-written baseline from participants;
- TODO:
  - Evaluation in more domains;
  - Integration with NLP.

https://arxiv.org/abs/2302.10809

Contributions:

1. CEMA: A novel framework of Causal Explanations for stochastic Multi-Agent decision-making
2. Without assuming a causal structre, our method is applicable whenever predictive model is available.

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