Provably Correct Shared Control for Human-Embedded Autonomous Systems

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Challenge:

- Humans and autonomy are responsible for collective information acquisition, perception, cognition and decision-making at multiple and varying levels of abstraction.
- It is crucial to develop languages, algorithms and demonstrations for the formal specification and automated synthesis of shared control protocols.

Solution:

Combine learning, formal methods and behavioral modeling for

- specification and modeling for shared control,
- automated synthesis of shared control protocols,
- shared control through human-autonomy interfaces.

Scientific Impact:

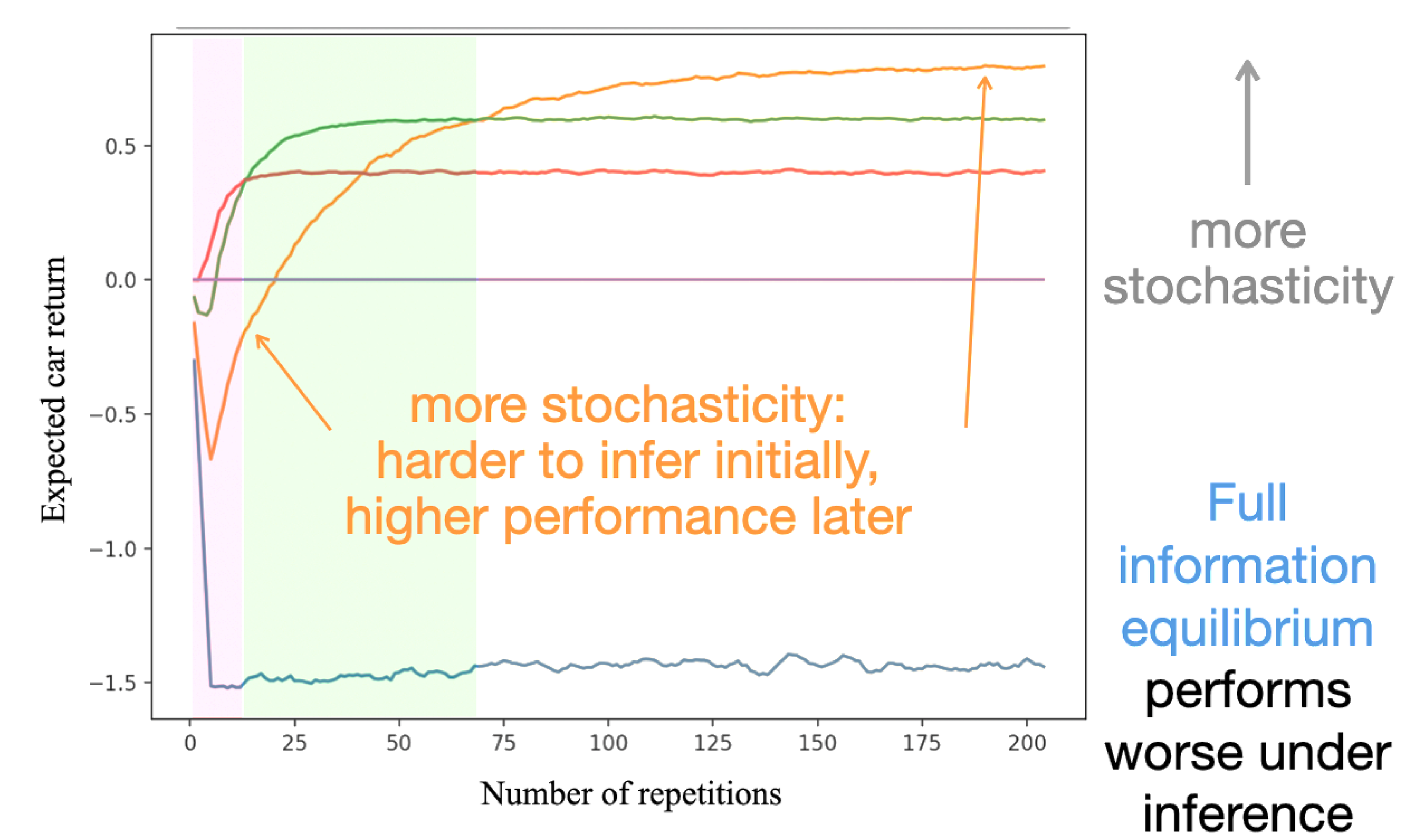
Human-embedded autonomy widely appliable in CPS.

Broader Impact:

Outreach to elementary and high school students and outreach through institutional programs and local community engagement.

Human-autonomy interaction modeled as a repeated Stackelberg game:

- Autonomous system uses a fixed strategy (e.g., a software)
- Human responds to autonomous system's strategy



If human does not know the system's stochastic strategy, both parties suffer from transient inferability losses in cooperative settings.

Use inferable (less stochastic) and performant strategies

Leader's expected return under inference

Rationality level

Game-related constants

Stochasticity level of leader's strategy x

$$\sum_{k=2}^{K} IR_{k,\lambda}(x) \geq (K-1)SR_{\lambda}(x) - \sum_{k=2}^{K} \frac{\lambda \, r^c r^p n \sqrt{m} \, \nu(x)}{4\sqrt{(k-1)}}$$

Stackelberg return

lower total variance → lower inferability loss

lower rationality level λ → lower inferability loss

longer horizon K → lower average inferability loss

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