Cost Inference in Smooth Dynamic Games from Noise-Corrupted Partial State Observations

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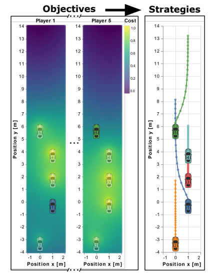
Dynamic Games

Given

- Joint state dynamics
  $x_{t+1} = f\left(x_t, u_t^1, \ldots, u_t^N\right)$
- Player objectives
  $J^i := \sum_{t=1}^{T} g_t^i(x_t, u_t^1, \ldots, u_t^N)$

Find

- Nash equilibrium strategies

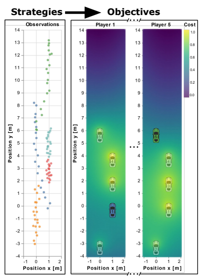


Inverse Dynamic Games

Given

- Observations
  $\mathbf{y} \sim p(\mathbf{y} \mid \mathbf{x}, \mathbf{u})$
- Dynamics
  $x_{t+1} = f\left(x_t, u_t^1, \ldots, u_t^N\right)$

Which objectives explain the observed behavior?



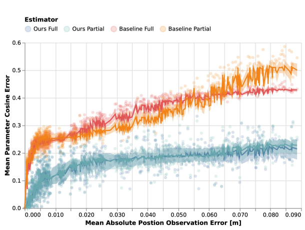
Objective Inference as Guided Equilibrium Search

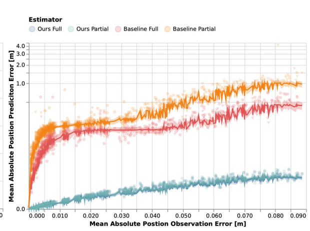
$$\min_{\theta, \mathbf{x}, \mathbf{u}, \boldsymbol{\lambda}} \sum_{t \in [T]} \|y_t - h(x_t)\|_2^2$$

$$\text{s.t.} \begin{bmatrix} \left.\begin{matrix} \nabla_{\mathbf{x}} J^i + \boldsymbol{\lambda}^{i\top} \nabla_{\mathbf{x}} \mathbf{F}(\mathbf{x}, \mathbf{u}) \\ \nabla_{\mathbf{u}^i} J^i + \boldsymbol{\lambda}^{i\top} \nabla_{\mathbf{u}^i} \mathbf{F}(\mathbf{x}, \mathbf{u}) \end{matrix}\right\} \forall i \in [N] \\ \mathbf{F}(\mathbf{x}, \mathbf{u}) \end{bmatrix} = \mathbf{0}$$

Can be encoded by existing modeling languages for constrained optimization.

Results





Baseline: Cost inference on pre-filtered states.

Code
github.com/PRBonn/PartiallyObservedInverseGames.jl