Approximate solutions to games of ordered preference

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Games of ordered preference model multi-agent interactions with individual rankings over multiple objectives

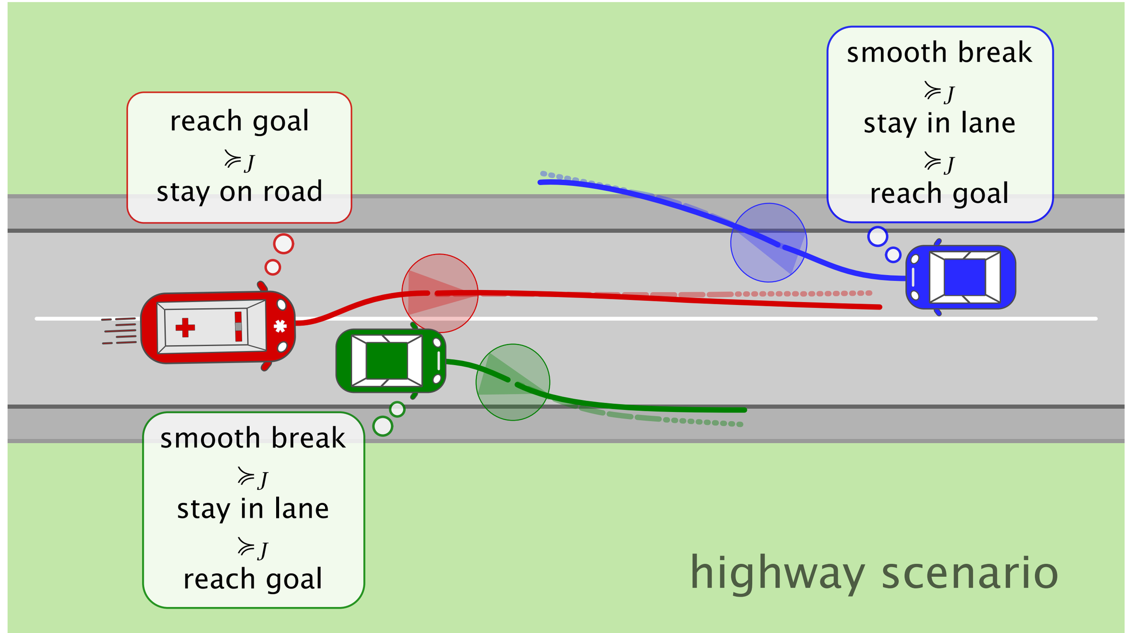
Preferences

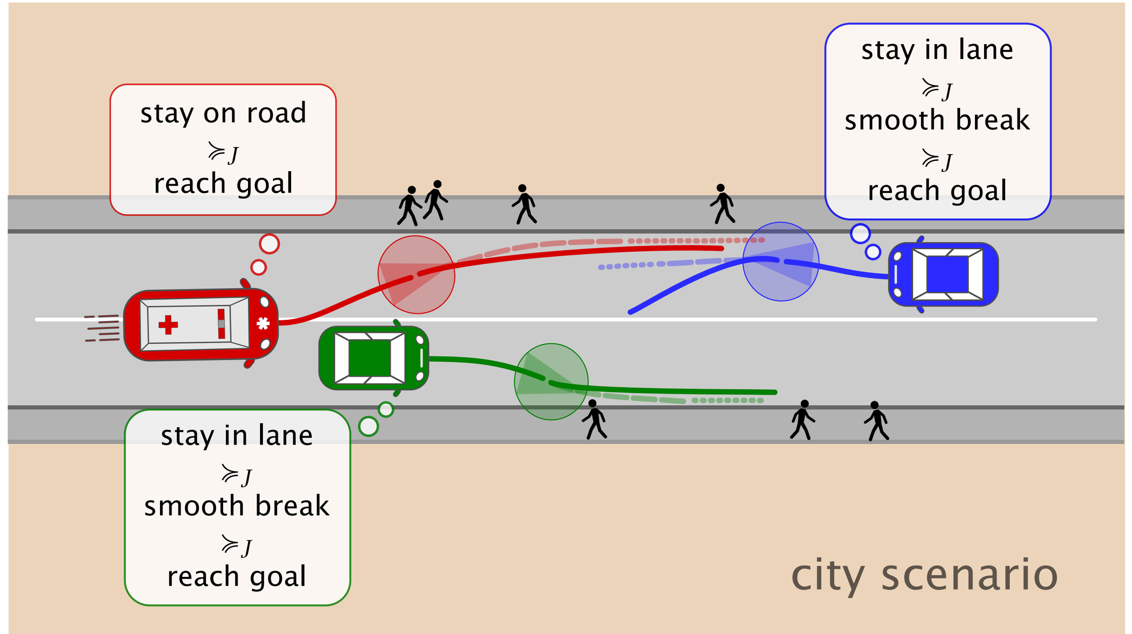
are total order relations $\succcurlyeq_J$ on objectives
e.g. in a traffic scenario, avoid collisions $\succcurlyeq_J$ reach goal

describe priorities between objectives
e.g. driving in a highway vs. through a city

can be different for each agent and context

induce a nested structure to the problem





The nested structure makes solving the joint problem intractable $\Rightarrow$

We introduce an algorithm that efficiently finds approximate solutions

Lexicographic Optimization

$J_1 \succcurlyeq_J J_2$ — J_1 is more important than J_2

sequentially solves optimization subproblems
optimize for highest priority objectives first

for each agent i across their K^i priority levels

$$\underset{\mathbf{z}^i_{K^i}}{\text{minimize}}\ J^i_{K^i}\left(\mathbf{z}^i_{K^i}, \mathbf{z}^{-i}\right)$$

$$\text{subject to } \mathbf{z}^i_{K^i} \in \underset{\mathbf{z}^i_{K^i-1}}{\operatorname{argmin}}\ J^i_{K^i-1}\left(\mathbf{z}^i_{K^i-1}, \mathbf{z}^{-i}\right)$$

decision variables

first objective

$$\ddots$$

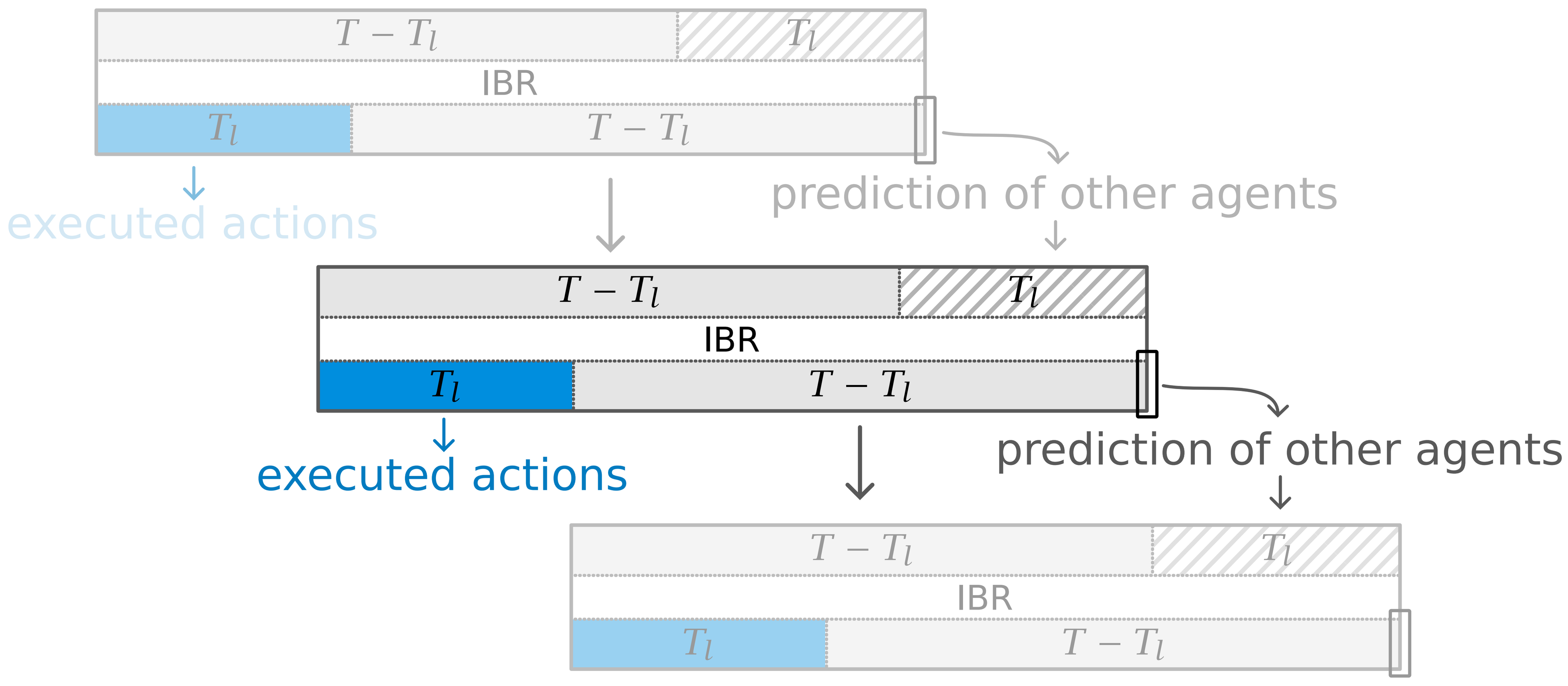
$$\text{subject to } \mathbf{z}^i_2 \in \underset{\mathbf{z}^i_1}{\operatorname{argmin}}\ J^i_1\left(\mathbf{z}^i_1, \mathbf{z}^{-i}\right)$$

$$\text{subject to } \mathbf{z}^i_1 \in \mathcal{Z}$$

The solution to the optimization problem is a Nash equilibrium for the game

Lexicographic iterative best response over time continuously solves decoupled problems with fixed opponents

it uses information of past intentions to make predictions that accelerate convergence



The aggregation of individual trajectories is an approximate-optimal solution to the original problem