

A CONCEPTUAL FRAMEWORK FOR SHARED AUTONOMY: EXTENDED ABSTRACT

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Abstract

- Shared autonomy is not only about who acts, but also about how interaction shapes execution [1].
- We propose a decision-theoretic perspective where *interaction context* participates directly in planning.
- Our framework supports mixed initiative behavior while remaining compatible with standard MDP methods.

Introduction

- Human AI systems require continuous coordination between autonomous execution and human involvement.
- Existing models often treat interaction as external control logic or as implicit transition structure [2].
- We view interaction as part of the planning structure itself.

⇒ **Traditional** : state + action → transition

⇒ **Our Perspective** :

state + action → interaction context → transition

Conceptual Perspective on Shared Autonomy

Interaction Aware State

- The interaction aware state is $s = (x, c)$, where x is task state and c is interaction context.
- The interaction context encodes initiative, responsiveness, and coordination state.

Implicit Interaction Mediation

- Actions do not determine future states independently. Their realization depends on interaction context.

$$(x, c), a \implies (x', c')$$

- Interaction context mediates how transitions unfold.

Key Interpretation

- Interaction is not merely an additional state feature.
- It structures how actions translate into future system evolution.

Why This Matters

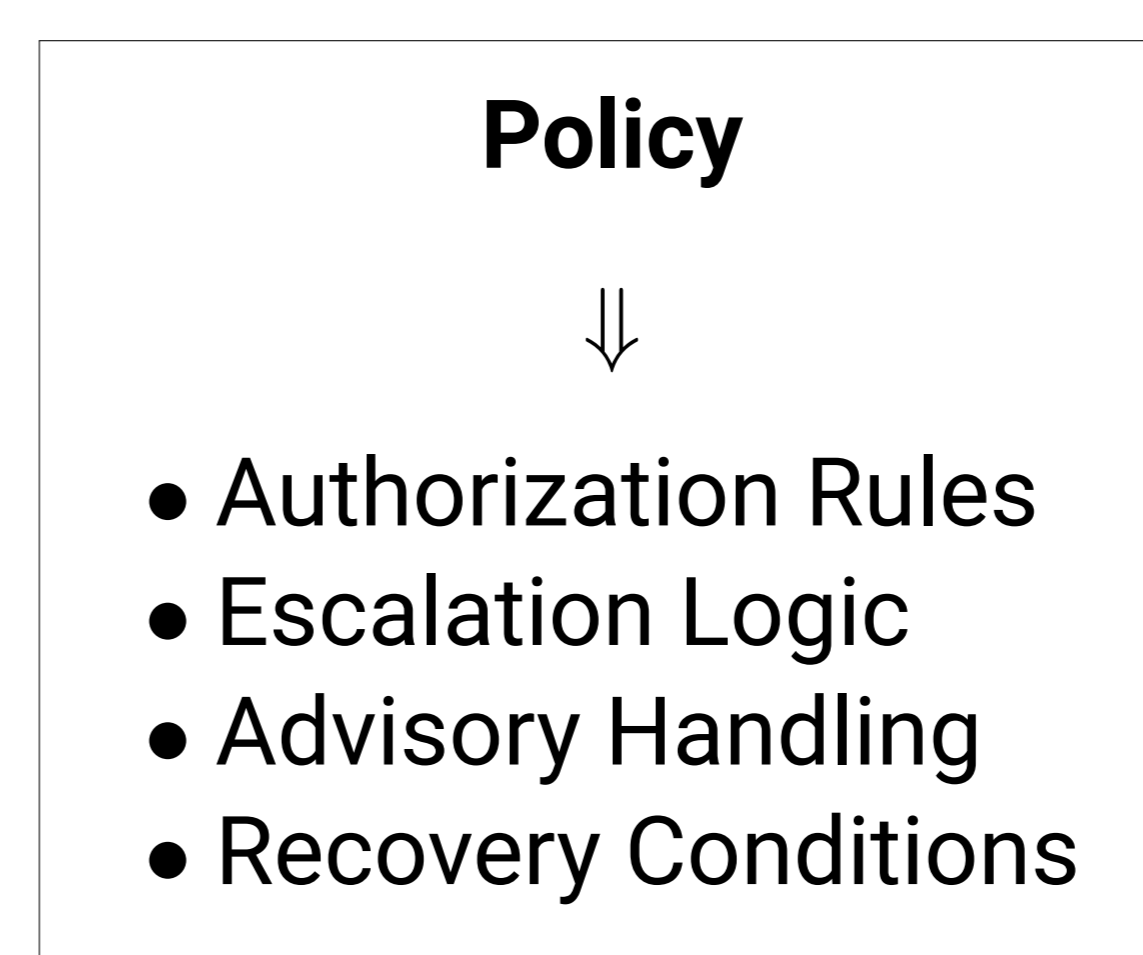
- In shared autonomy, the same action may lead to different outcomes depending on interaction conditions such as responsiveness, initiative, or acceptance of guidance.
- Planning must therefore account for how interaction shapes execution and future coordination.
- This supports mixed initiative behaviors including advisory interaction, deferred execution, authorization requests, and engagement aware decision making.

Positioning

- Prior shared autonomy approaches often encode interaction effects implicitly through transition structure or external control assumptions [2].
- Our framework remains compatible with standard MDP methods while supporting asymmetric authority and dynamic engagement.

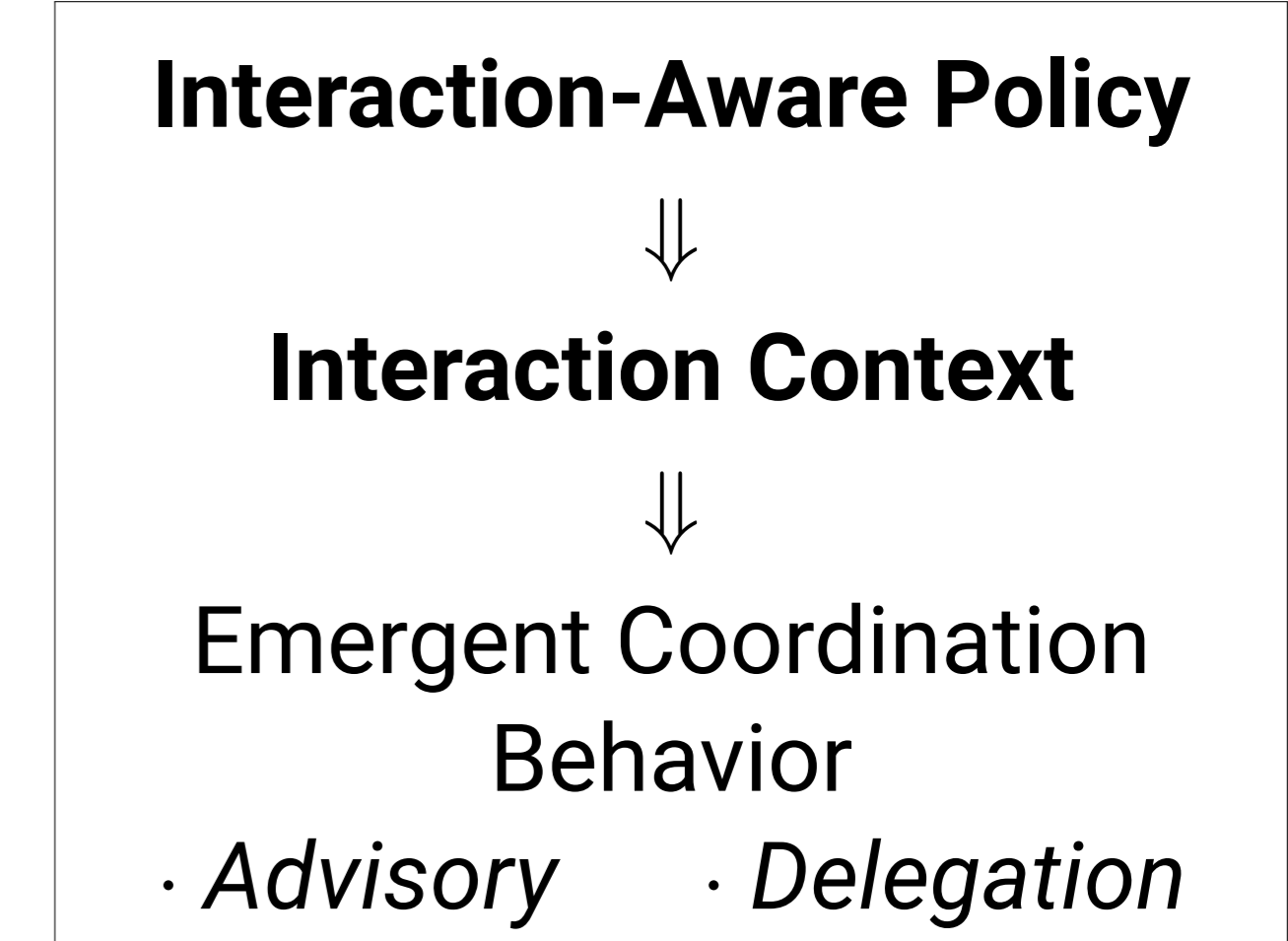
Conceptual Contributions

Existing Design



Multiple external interaction mechanisms

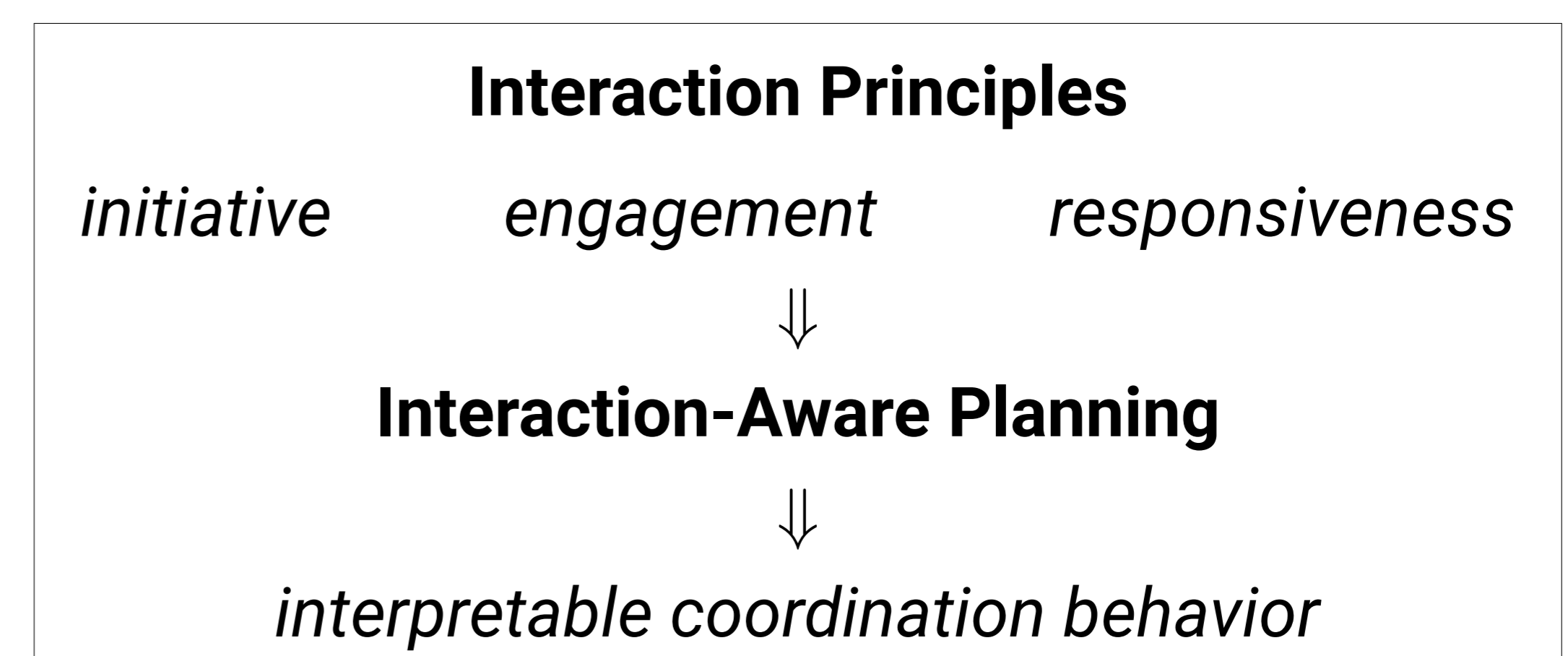
Proposed Perspective



Interaction structure integrated into planning

- Interaction context participates directly in how actions are assessed and realized.
- Rich interaction behaviors emerge from interaction structure rather than externally engineered coordination rules.
- The resulting policy design remains interpretable, manageable, and compatible with classical MDP computation.

Design Perspective and Implications



- Interaction mechanisms need not be engineered as separate modules.
- Interaction principles become part of the planning representation.
- Coordination behavior can therefore be interpreted through interaction context.

Current Scope and Future Directions

- We focus on a single human and single AI agent setting to isolate the role of interaction structure in planning.
- The current formulation emphasizes the conceptual interaction layer while remaining computationally tractable.
- Richer semantic instantiations and broader classes of interaction protocols remain directions for future investigation.

Acknowledgments and References

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[1] M. Bonner, R. Taylor, K. Fletcher, and C. Miller : Adaptive automation and decision aiding in the military fast jet domain. Proc. of Human Performance, Situation Awareness, and Automation, 2000.

[2] L. Vanhée, L. Jeanpierre, and A.-I. Mouaddib : Optimizing Requests for Support in Context-Restricted Autonomy. Proc. of IROS 2021.