Leadership Emergence Model Comparison

Model Documentation

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Contents

1 Model Overview

This document provides a detailed comparison of leadership emergence models, starting with the base model and showing how variations build upon it. Each model component is described with its theoretical basis, implementation details, and validation metrics.

2 Model Components

2.1 Agent Elements

Element	Base Model (A)	Model B	Theoretical Basis
Leadership Characteristics	Leadership Characteristics agent i	...	Social-cognitive
ILT	ILT for agent i	ILT represents empirical distribution	Leadership categorization
Leader Identity	Leader identity for agent i	...	Identity theory
Follower Identity	Follower identity for agent i	...	Role theory

Table 1: Agent Elements Comparison

2.2 Element Assumptions

Rule	Base Model (A)	Model B	Validation
Rule 1	Leader/Follower identity is uniform distribution	...	Distribution tests
Rule 2	ILT represents uniform dist. cutoff	ILT represents distribution based on empirical literature	Empirical fit
Rule 3	Leader characteristic represents uniform dist. cutoff	...	Distribution tests

Table 2: Element Assumptions Comparison

2.3   Interactional Rules

Rule	Base Model (A)	Model B	Mechanism
Rule 1	Only two interactants at a time	...	Dyadic interaction
Rule 2	Agents first claim, and then grant	...	Sequential process
Rule 3	Grant: Agents compare other agent's leader characteristic to their ILT	...	Recognition process
Rule 4	Claim: Agent's claim based on probabilistic cutoff from Leader identity	...	Identity expression

Table 3: Interactional Rules Comparison

2.4   Environmental Context

Assumption	Base Model (A)	Model B	Impact
Environmental 1	There are four agents	...	Group dynamics
Environmental 2	There is outside task or objective beyond the interactions	...	Task context

Table 4: Environmental Context Comparison

3 Parameter Details

3.1 Distribution Parameters

Parameter	Range	Default	Description	Sensitivity
Identity Distribution	[0, 1]	Uniform	Initial identity values	High
ILT Distribution	[0, 1]	Model specific	Leadership prototype	High
Characteristic Distribution	[0, 1]	Uniform	Leadership traits	Medium

Table 5: Distribution Parameters

3.2 Interaction Parameters

Parameter	Range	Default	Description	Sensitivity
Claim Threshold	[0, 1]	0.5	Minimum identity for claim	High
Grant Threshold	[0, 1]	0.5	Minimum match for grant	High
Update Rate	[0, 1]	0.1	Identity update speed	Medium

Table 6: Interaction Parameters

4 Validation Metrics

4.1 Pattern Metrics

- **Emergence Speed**: Time steps until stable leadership structure

- **Structure Stability**: Variance in leadership roles over time

- **Role Distribution**: Distribution of leadership claims/grants

- **Interaction Patterns**: Network analysis of claim/grant patterns

4.2 Theoretical Predictions

- **Base Model**:

  - Gradual emergence through repeated interactions
  - Stable leadership structure over time
  - Role differentiation based on initial conditions

- **Model B**:

  - Faster emergence due to empirical ILT distribution
  - More consistent with observed leadership patterns
  - Better alignment with theoretical predictions

5 Implementation Notes

5.1 Key Classes

- **Agent**: Implements individual characteristics and behaviors

- **Model**: Manages simulation environment and interactions

- **Metrics**: Calculates validation metrics and patterns

5.2 Simulation Flow

1. Initialize agents with distributions 2. Select interaction pairs 3. Process claims and grants 4. Update identities 5. Record metrics 6. Repeat until convergence