

Agent-Based Simulation of Cooperative Dairy Systems in NetLogo

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Abstract

This paper presents an agent-based simulation framework integrating the PROMETHEUS methodology with a Collective Intelligence Genome approach to model decentralized decision-making processes in rural dairy cooperatives. The proposed framework was applied to ASPAVISO, a Colombian milk producers association operating under voluntary participation and market competition conditions. The model was implemented in NetLogo through the direct translation of PROMETHEUS artifacts into computational structures, including agent roles, beliefs, desires, intentions, coordination protocols, and behavioral plans. The Collective Intelligence Genome introduced four analytical dimensions—What, Who, Why, and How—to characterize motivational drivers, coordination mechanisms, and emergent organizational dynamics. Producers autonomously decide whether to deliver milk to the cooperative or to external collectors according to economic pressure, loyalty, cognitive biases, and institutional incentives. Simulation results demonstrate the emergence of collective behavioral patterns such as loyalty reinforcement, progressive defection, production instability, and adaptive coordination without centralized control. The study contributes a traceable methodological bridge between agent-oriented software engineering and computational social simulation, offering industrial engineering researchers a structured approach for analyzing collective intelligence and organizational sustainability in socio-productive systems.

Keywords

Agent-Based Modeling, Collective Intelligence, PROMETHEUS Methodology, NetLogo, Dairy Cooperative Simulation.

Biographies

Dr. Lindsay Álvarez-Pomar is an Associate Professor and researcher in Industrial Engineering. She obtained her PhD in Engineering, with emphasis in Information Science and Knowledge. Her academic background also includes a master's degree in industrial engineering from Universidad de los Andes. In addition, she is an Industrial Engineer who graduated from Universidad Distrital Francisco José de Caldas. Currently, Professor Alvarez-Pomar is a professor at the Universidad Distrital Francisco José de Caldas. Her research interests include collective intelligence, urban mobility, simulation, knowledge management and production management. She is co-founder and researcher of the research group SES (Business and social systems) at the same university.

Ing. Danna Gabriela Espitia Cano is a graduate student in Industrial Engineering at the Universidad Distrital Francisco José de Caldas, Bogotá, Colombia. Her academic and research interests include agent-based modeling, collective intelligence, computational simulation, complex adaptive systems, and decision-making processes in socio-technical environments. She has participated in research activities related to multi-agent systems, NetLogo simulation, and the application of engineering methodologies for the analysis of organizational and social dynamics. Her current work focuses on integrating PROMETHEUS-based agent architectures with collective intelligence frameworks to study decentralized coordination, emergent behavior, and sustainability in cooperative and urban systems.