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Observer-Based Adaptive Robust Control of Dual-Layer Multiagent Epidemic Models

This work proposes an innovative dual-layer multi-agent-based SIS epidemic model that integrates a physical contact layer and an information layer. The physical layer captures disease transmission through travel or migration between cities, while the information layer enables the exchange of infection data among healthcare providers across cities, even in the absence of direct physical connections. An observer is designed to estimate the infected fraction in each city by utilizing information from neighboring cities connected through the physical layer in a distributed manner. These estimates are subsequently used in the information layer to synchronize each city's infection trajectory with that of a virtual leader. Furthermore, the control input, typically defined in multi-agent systems, is employed as the sliding surface, whose stability is proven via Lyapunov analysis within the dual-layer SIS framework. To handle parameter uncertainties and ensure convergence to the sliding surface, an adaptive sliding mode control strategy is developed, effectively integrating the dynamics of the physical and information layers to drive the system toward disease eradication. This is a joint work with Zohreh Abbasi.