From Simulation to Digital Twins of Socio-Economico-Techical Complex Systems

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Integrating DevOps methodologies with agent-based modeling tools is transforming the simulation of collective behaviors in complex systems. By combining DevOps with multi-agent simulation (MAS) tools, this approach provides a comprehensive view of agent interactions, enhancing our understanding and optimization of systems' emergent properties. These tools are invaluable in diverse fields including socio-economic systems like healthcare systems [3] and urban planning [1]. DevOps cycles enhance MAS by facilitating continuous integration and deployment, crucial for adapting to complex system analysis and supporting iterative development and testing. This enables immediate refinements to simulations, improving model efficiency and effectiveness.

The integration also allows for faster scaling and adaptation of simulations to new scenarios, making it possible to handle unexpected system dynamics swiftly. This adaptability is crucial in sectors like emergency management and environmental monitoring, where conditions can change rapidly and require quick adjustments to models. Additionally, the collaboration between developers and operations facilitated by DevOps helps in aligning the objectives of technology with business goals, ensuring that the simulations not only are technically proficient but also deliver value according to user needs.

A significant advancement is the evolution from basic models to digital twins, which incorporate AI to mirror physical systems in real time, offering vital analytics for complex system management such as smart grids [2]. These digital twins can simulate scenarios in a controlled environment, providing insights that prevent costly real-world errors. They are becoming essential in fields like manufacturing and logistics, where they help in optimizing operations and predicting system failures. However, digital twins face challenges like accurately modeling the complexity of socio-economic systems and managing computational demands. These challenges involve ensuring that the models are not only comprehensive but also manageable and responsive.

Overall, while DevOps integration with MAS improves complex system modeling, the transition to digital twin technology presents new challenges and opportunities, necessitating careful management of model fidelity, computational resources, and data.

References

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