

TOWARDS AGENT-BASED DIGITAL TWINS FOR DISASTER MANAGEMENT

700: DIGITAL TWINS

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ABSTRACT

Agent-based models have proven to be useful tools in supporting decision-making processes in different application domains. The advent of modern computers and supercomputers has enabled these bottom-up approaches to realistically model human mobility and contact behavior.

Taking the next step and combining realistic agent-based models with up-to-date or real-time data yields powerful agent-based digital twins that can help to save lives or protect human health endangered in situations of disaster or catastrophes.

In [1], the authors have recently presented a city-scale agent-based model that was capable to evaluate advanced testing and isolation strategies during the COVID-19 pandemic. Bi-directional coupling of simulations as proposed in [2], at the example of an agent-based pedestrian simulation with an electrical simulation in an airport terminal, allows to test contingency plans in saboteur scenarios.

However, for agent-based digital twins to be useful in different situations of disaster very different requirements need to be fulfilled. For large-scale catastrophes such as pandemics or country-wide network shutdowns, the corresponding agent-based models need to scale well on supercomputing infrastructure to allow the simulation of millions of agents in a fraction of second. For small-scale perils such as the local leakage of a chemical hazard, fine-granular pedestrian dynamics are needed. Moreover, future integration of real-time data with agent-based simulations could leverage its applications in adaptive emergency planning.

By attending this symposium, participants will gain a deeper understanding of agent-based digital twins that can help decision makers and domain experts to protect humans from danger caused by disasters of different nature.

The symposium will explore different approaches to agent-based digital twins with its domain specific challenges, including:

- Fine-granular pedestrian movement models to protect humans in situations of chemical, thermal or mechanical dangers or catastrophes
- Small- to large-scale models to react to network or cyber catastrophes
- Large-scale models to protect human health in times of pandemics
- Impact estimation of disasters in the context of contingency planning and risk analysis
- Integration of real-time data with agent-based models for improved emergency management

REFERENCES

- [1] Kerkmann et al., *Agent-based modeling for realistic reproduction of human mobility and contact behavior to evaluate test and isolation strategies in epidemic infectious disease spread*, Computer Methods in Biology and Medicine (Accepted).
- [2] Nellinger et al., *A Multi-Layer Navigation Approach for Interactive Pedestrian Flow Simulation in Digital Twins*, 15th International Conference on Simulation and Modeling Methodologies, Technologies and Applications, SIMULTECH 2025 (Accepted).