KER 9 | MATHEMA
Device Simulator

TYPE
[SERV] [METH]

TECHNICAL READINESS LEVEL
TRL5

INTELLECTUAL PROPERTY RIGHTS
PROPRIETARY

EXPLOITATION ROUTE
OPEN SOURCE | SOFTWARE REGISTRY

The simulator is the engine that drives the movement and actions of virtual people within the Urban Digital Twin. It replicates real-world behaviours to help us study and optimize urban scenarios. It is also helpful to simulate a large amount of scenarios in order to train the EXTRACT Multi-Agent Reinforcement Learning system (MARL).

KEY BENEFITS FOR THE PER USE CASE

The device simulator serves as a high-fidelity, controlled environment for training the reinforcement learning (RL) model, offering a scalable and cost-effective alternative to real-world experimentation. By simulating diverse emergency scenarios with varying environmental conditions, agent behaviors, and constraints, the simulator enables the RL model to explore a wide range of possible responses in a risk-free setting. This controlled variability enhances generalization, allowing the trained model to adapt to unforeseen real-world situations. It also enables the incorporation of domain-specific constraints, such as mobility limitations, ensuring that the learned policies remain feasible when we introduce different environments.
Simulating correctly the behavior of the devices when they receive a suggested action from the model, the simulator guides the RL agent in refining its decision-making process, leading to the generation of precise and contextually aware action sequences that can be effectively translated into human-understandable emergency instructions. The ability to simulate rare or dangerous scenarios—such as large-scale evacuations or infrastructure failures—further strengthens the robustness of the model, ensuring that it can provide reliable guidance even in high-stakes situations.

FOR RESEARCHERS AND INDUSTRIAL TEAMS:

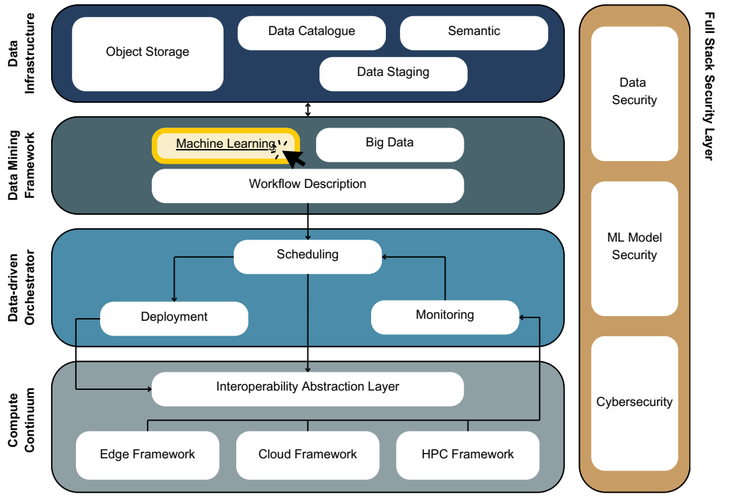
- Enables the study of RL-based decision-making in emergency scenarios without real-world risks
- Minimizes the need for real-world prototyping, saving time and resources in development.
- Provides a consistent testing ground for comparing different RL algorithms and policies.
- Allows fine-tuning of parameters such as mobility patterns, communication constraints, and environmental hazards

FOR ADMINISTRATORS AND CDOS:

- Supports data-driven decision-making for emergency response planning and crisis management.
- Enables administrators to implement AI-generated emergency instructions that are clear, effective, and practical.

USE AND IMPACT BEYOND EXTRACT

Beyond its current application in emergency response, this solution can be leveraged across various industries that require intelligent decision-making in dynamic environments. In smart cities, it can optimize traffic flow and pedestrian evacuation strategies during large-scale events or disasters. In industrial safety, it can train AI-driven protocols for hazardous environments, reducing workplace accidents. Logistics and supply chain management can benefit from simulating disruptions and optimizing rerouting strategies in real-time. In autonomous systems, such as self-driving cars and drone fleets, the simulator can enhance AI training for navigation and obstacle avoidance. Additionally, in military and defense, it can be used for tactical simulations, enhancing strategic planning and coordination. The versatility of this approach allows organizations across different domains to improve safety, efficiency, and adaptability through AI-driven scenario modeling.



https://gitlab.bsc.es/extract/extract-use-cases/per/rl-agent

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