TECHNISCHE UNIVERSITÄT DARMSTADT

Fachbereich 18
Elektrotechnik und Informationstechnik

Institut für Nachrichtentechnik

Self-Organizing Systems

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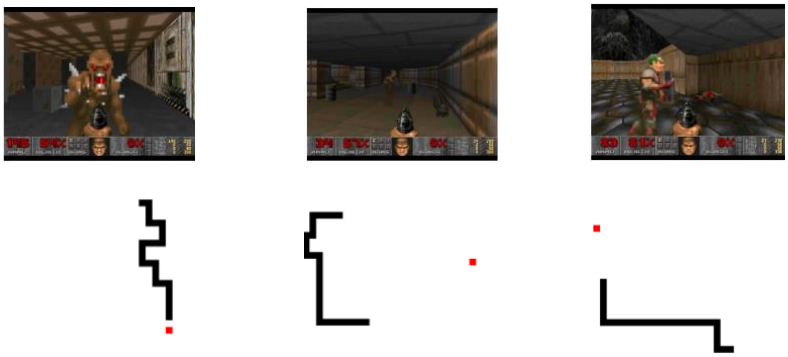
Head of lab

Bachelor/Master thesis
Game-Engine Simulation using Diffusion Models



This thesis investigates the application of Diffusion models based on Continuous-time Markov Chains (CTMCs) to emulate engines of countable state-space diffusion models. Diffusion Models have recently been used for state-of-the-art image and video generation[1]. While these models are based on stochastic differential equations, approaches exist for discrete data. We want to improve upon these frameworks and provide new use cases.
Games are usually run on an engine, a program that applies the game's logic based on user inputs and the current game state and returns a new state with a corresponding image called a frame. The goal is to develop a framework that lets a user play a video game without using the game engine but a neural network that infers the next frame autoregressively based on the current frame and user input instead[2]. This should be done using a diffusion process based on CTMCs[3].
Once this is accomplished, the long-term goal is to transfer this method to establish a "game engine for cells" that infers cell states, simulating the dynamics of cell conditions and their responses to external influences.

Some of the following may help:

- Good Python skills, preferably with PyTorch
- Deep Learning Expertise

For further information, please contact Yannick Eich or Sebastian Wirth.

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17. Februar 2025

[1] Rombach, R., Blattmann, A., Lorenz, D., Esser, P., & Ommer, B. (2022). High-Resolution Image Synthesis with Latent Diffusion Models. arXiv preprint arXiv:2112.10752. https://doi.org/10.48550/arXiv.2112.10752
[2] Valevski, D., Leviathan, Y., Arar, M., & Fruchter, S. (2024). Diffusion Models Are Real-Time Game Engines. arXiv preprint arXiv:2408.14837. https://doi.org/10.48550/arXiv.2408.14837
[3] Campbell, A., Benton, J., De Bortoli, V., Rainforth, T., Deligiannidis, G., & Doucet, A. (2022). A Continuous Time Framework for Discrete Denoising Models. arXiv preprint arXiv:2205.14987. https://doi.org/10.48550/arXiv.2205.14987