Abstract

Agent-based modeling (ABM) offers a powerful approach to simulating autonomous entities in dynamic environments. Unlike traditional rule-based systems, ABM allows individual agents to make decisions, interact with their surroundings, and adapt to changing conditions, leading to emergent and realistic behaviors. This approach has applications in various domains, including crowd simulation, procedural storytelling, and artificial intelligence development, where complex interactions and adaptive behaviors are essential. ABM can also be used for testing and optimizing systems, analyzing emergent patterns, and enhancing decision-making processes in interactive environments.

For this project, I created an agent-based simulation modelled after the video game *Animal Crossing: New Horizons*. *Animal Crossing: New Horizons* is a life-simulation game where players live on an island with animal villagers and engage in activities like fishing, bug catching, and decorating. Each villager has a distinct personality that influences what activities they will partake in and how they will interact with others. Time is implemented by simulating their behaviors at each hour of the day. Using this simulation, we can ask where do the villagers like to congregate? How much does personality affect productivity? Do certain villagers interact more with certain villagers?

Application and Literature

The first ABM has been credited to the economist Thomas C. Schelling. In 1971, he developed Dynamic Models of Segregation that simulated how individual preferences could lead to unexpected large-scale patterns, specifically in urban racial

segregation (Schelling 1971). The agents were the households on his grid and each had a threshold for how many similar neighbors they preferred. If too many neighbors were different, the agent would move to a new location until it was within its threshold. Over time this led to complete segregation which is evident today in cities like Chicago.

ABM has been crucial in modeling the spread of infectious diseases, such as COVID-19. Papers like Kerr et al.'s (PLoS Computational Biology, 2021) demonstrate how ABMs can assess the impact of public health interventions, such as lockdowns and vaccination campaigns, by simulating how individuals interact and transmit the virus under different policy scenarios. Similarly, ABM is extensively applied in transportation research to study traffic flow, congestion, and autonomous vehicle behavior. Nguyen et al. (*Transportation Research Interdisciplinary Perspectives*, 2021) provides an overview of agent-based traffic simulators, emphasizing their ability to capture the dynamics of individual driver behaviors and road networks. ABM has become a powerful tool for understanding emergent phenomena that traditional equation-based models struggle to capture.

Approach

The Python module Mesa was the primary tool for building this agent-based simulation. Mesa is a powerful framework designed for building, analyzing, and visualizing ABMs. It provides a flexible and modular environment that allows researchers and developers to simulate complex systems where individual agents interact with each other and their environment. To ensure the simulation closely mirrored the game, necessary information was gathered from public wikis. The

simulation incorporated eight predefined personalities that influenced the villagers' hobbies and sleep patterns.

Results

Per simulation run high traffic areas, clusters of villagers, and cluster movement of villagers over time was observed. Each run had a specific cell that had the most traffic. This could indicate where points of interest and congregation are e.g. town square. Observing the cluster of villagers, three distinct clusters are spread across the map. This could indicate that the villagers stick to distinct areas e.g. residential or market zones. Lastly, due to the randomness of a villager's chosen activity and duration, the cluster movement of villagers over time shows erratic patterns. The movements in the early hours are steady which reflects the sleep patterns of each personality.

This simulation is a very basic model of *Animal Crossing*. To simplify the project, each of the time steps reflected one hour and each of the activities had durations in hours. The real game uses real time and a better model would observe down to the second. The game also has other features not reflected in the simulation like mood, memories, randomly generated terrain, and weather systems. Future enhancements could improve the model's accuracy and utility, serving a better basis for a video game simulation.

References

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