Behavioral Dynamics Approach to Collective Crowd Behavior

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The collective motion of flocks, schools, and crowds is thought to emerge from local interactions between individuals. The key to explaining such collective behavior thus lies in characterizing the nature of these local interactions. We take an experiment-driven, bottom-up approach to modelling collective motion, beginning with the dynamics of local pedestrian interactions and then predicting the emergent crowd behavior. Based on experiments in an ambulatory virtual environment, we have developed a pedestrian model that reproduces elementary behaviors such as steering, obstacle avoidance, and pedestrian alignment, modeled as second-order systems. In current work, we investigate how a pedestrian is influenced by multiple neighbors in a virtual crowd, and have formalized a novel neighborhood structure. Combining the alignment dynamics with the neighbourhood model in multi-agent simulations, we can reproduce individual trajectories in motion-capture data on a human 'swarm', and generate globally coherent motion. This approach yields the first bottom-up model of pedestrian interactions and accounts for collective crowd motion. The results support the view that crowd behavior emerges from local interactions, without internal models or plans, consistent with principles of self-organization.