Flocking Behaviour: Agent-Based Simulation and Hierarchical Leadership

1. What it is about

This study examined the emergence of leaders in a group as a consequence of the interaction between its members. In general, it studied pack behaviour without a centralised leader, which is present in many animal species. Packs have similar properties to the dynamics and organisation of human groups. It is assumed that an individual who becomes a leader does not have any obvious signs that distinguish him or her in the pack, but is perceived as a leader as a result of social interaction in the group. In other words, the emergence of a leader is not the influence of external factors, but the result of a self-organised process that arises as a result of simple local rules that regulate the dynamics of relations in our group.

2. What is the model

Agents move in a two-dimensional closed or open world consisting of cells (or patches), where one cell can be occupied by only one agent at a time (i.e., there is no layering of agents). Each agent is identified by its coordinates and direction at time t. The direction of an agent at time t is defined as the vector connecting its location at time t-1 and its current location, and is expressed as the counterclockwise angle between this vector and the oX axis. Agents have a perceptual field, defined as a circular sector centred on the agent's current location and intersected by the vector of its current course; the radius ri and angle θi of the circular sector are the depth and volume of agent i's perceptual field, respectively, and are model parameters that can be changed. The Ideal Distance matrix is also defined, where the distances from agent i to agent j are recorded, i.e., at what distance Dij agent i wants to be from agent j at a given time. The ideal distance is not necessarily symmetrical. Euclidean distance.

At time t, the agent also calculates her ideal or possible future dissatisfaction at the future time t+1 for all candidate positions p in her current environment by calculating the distances to them. Then the agent decides to move to the position with the lowest level of dissatisfaction. If several positions have the same minimum level of dissatisfaction, the agent chooses the one that requires the least change in its current course. This agent may have conflicts with other agents, so it is possible that its minimum dissatisfaction is not achieved. The decision to move within their neighbourhoods is made independently by the agents. At each time point, if there is an overlap between agents' areas, their priority to move to minimum dissatisfaction is sorted in a random order. Agents with lower priorities will only be able to move to cells that have not been selected by agents with higher priorities and that provide less than minimum dissatisfaction.

3. Why it is important

- The biological component - understanding pack behaviour helps in the study of human behaviour in certain situations, such as during evacuations. In crisis situations, people tend to follow those who appear strong and confident, so studying these behaviours can help to effectively develop crowd management models in crisis situations.

- The influence of leadership on social decisions, how the number and quality of leaders affects whether people will follow them, what behaviours determine the leader among which cells of people, how people react to frequent changes of leaders, and whether it is advisable to have many leaders in a group.

4. What are the results

The results showed that the bigger the world was, the more difficult it was for a flock to emerge, as agents that were more scattered tended to take longer to begin interacting with one another. Conversely, the smaller the world, the less stable the flocks that emerged, as the amount of interaction among the agents increased and they were more likely to change continuously in a small world, which led to flocks that emerged and disbanded often.