Flocking Behavior

We all know what a flock is, it refers to a group of birds flying or foraging together. Have you ever wondered why birds do that? Such collective behavior is not unique to birds It's a rather common sight in nature, both at microscopic and macroscopic levels. Fishes exhibit shoaling, many land animals move as herds. Collective motion of bacteria such as E.Coli.

Why would these organisms seem to co-ordinate themselves very well, say when foraging when they could just look for food in random places individually?

Is there a need for some form of central co-ordination needed for them to exhibit this collective behavior? In this simulation we try to tackle this problem by trying to figure out if there's really a need for central co-ordination or does this complex collective behavior simply arise out of the decisions made by individual 'birds' of the 'flock'.

Here, we refer to the organisms in question as boids(short for birdoid) and we try to come up with a simple set of conditions that an individual will follow.

They are as follows:

1. Separation: If two boids approach each other and within a certain proximity limit, they will decide to steer away to avoid potential collisions. There is no means of communication between the two.
2. Alignment: A boid tends to move in the direction in which the local boids are headed on average.
3. Cohesion: A boid will move to the average position of the boids around it locally.

The radii for both alignment and cohesion can be controlled in our simulation. As you play around with the values for these two parameters, you will always observe the "flocking" behavior. This complex collective behavior of the boids is arising because of just these 3 parameters that an individual boid keeps in check and is hence considered an emergent behavior.

We can now try to reason why is this so. This might seem counter-intuitive to the notion of the survival of the fittest, but in the eyes of an individual, if it sees a group in its locality heading somewhere it might be because: that group is either moving away from a predator or that group has found a resourceful foraging area. It might be because of many such reasons that benefit the individual.

How herding/flocking is advantageous for an individual organism of the group:

- Protection from predator:
  For a predator, it's strategy to efficiently hunt is to go after the closest prey.
  It is observed that when in a herd or flock, the chances of being predated are lesser than when an individual is alone.

Also, when some individual is threatened by a predator, it goes to the most inner part of the flock to guarantee safety and, hence avoiding predation.

- Reproductive advantages are also seen when cooperative breeding takes place inside a group. The weak young ones are also easily protected when being in group.
- Reduced energy expenditure by reduced turbulence is also seen when organisms use a certain formation to travel when in groups. For example, the V formation in geese.

Summing up, doing this results in an increased chance of survival for the individual. Applying this to a group of boids results in the behavior we observe.

We humans ourselves do this very often. When a considerable group of people in our vicinity is headed somewhere we tend to follow suit. This flocking model of boids was studied very well and further iterations on it were made. Flocking behavior simulations are well used in ecology. This model was used to fit the behavior of birds and humans too. It is very accurate at mimicking real world flocking/herding with a few tweaks that correspond to the organism/situation in question.

Further reading:

http://www.red3d.com/cwr/boids/ - A link to the webpage on Boids by the original creator of the program; Craig Reynolds.

https://en.wikipedia.org/wiki/Flocking_(behavior)

http://www.vergenet.net/~conrad/boids/

The Selfish Gene – book recommendation.