Bioinspired Design (Engn/Biol 267) Emergent Behavior of Fish and Birds and other Flocking Things Unit

Required Reading

1.Zimmer, C. (2007). From Ants to People, an Instinct to Swarm. *New York Times*, Nov 13, 2007.

Quick pop culture review of the burgeoning field of emergent behavior.

2. Couzin, I. D., Krause, J., James, R., Ruxton, G. D., & Franks, N. R. (2002). Collective memory and spatial sorting in animal groups. *Journal of theoretical biology*, *218*(1), 1-11. [www]

The original paper that really kick-started the entire field of emergent swarm behavior. Note how there are close parallels with physics "repulsion, attraction, orientation, center of mass", etc.

3. Ballerini, M., Cabibbo, N., Candelier, R., Cavagna, A., Cisbani, E., Giardina, I., ... & Zdravkovic, V. (2008). Interaction ruling animal collective behavior depends on topological rather than metric distance: Evidence from a field study.*Proceedings of the national academy of sciences*, *105*(4), 1232-1237. [www]

What happens when a bunch of physicist record bird flocks from the top of a Roman cathedral? They discover a new "rule" that birds follow. Spoiler alert: out of a massive flock, each bird needs to pay attention to only about 6 or 7 others.

Further Reading:

4. Couzin, I. D., & Franks, N. R. (2003). Self-organized lane formation and optimized traffic flow in army ants. *Proceedings of the Royal Society of London B: Biological Sciences*, *270*(1511), 139-146.

Ever seen an ant highway? This paper shows how they might form based on some simple behavioral rules of 'follow the leader'.

5. Shklarsh, A., Ariel, G., Schneidman, E., & Ben-Jacob, E. (2011). Smart swarms of bacteria-inspired agents with performance adaptable interactions.*PLoS computational biology*, *7*(9), e1002177.

Bacteria swarm too following the same rules as fish schools and bird flocks!