Multi Agent Systems

What is Swarm?
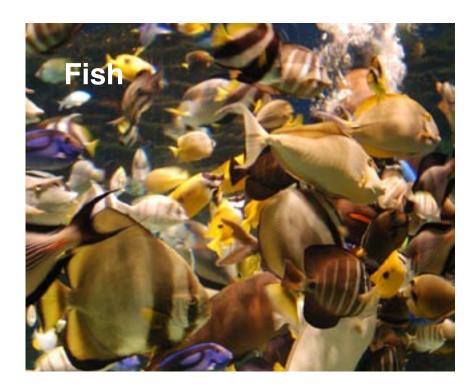
Swarm

The term swarm is applied to fish, insects, birds and microorganisms, such as bacteria, and describes a behavior of an **aggregation** of animals of **similar size and body orientation**, generally cruising in the same direction.

This is a partial list of animals that swarm:
Ants, Birds, Eels, Honey bees and Termites [1]

1.) From Wikipedia, the free encyclopedia

Fish

Swarm Design

Designing like Nature

Nature offers an amazing repertoir of approaches to design complex and elaborate systems. Instead of composing its entities from pre-fabricated parts, as is the standard way of our current engineering system designs, nature uses alternative approaches to find design solutions for the creation of its organisms, such as

**Structure formation,
Growth,
Self-assembly
Self-organization,
and Emergent system behaviours**

It still remains a major challenge to translate nature´s pool of design ideas into terms that we—as

**Artists,
Engineers,
Computer scientists,
and System designers**

can work with. [2]

2.) Christian Jacob, Evolutionary and Swarm Design, 2001

Swarm Intelligence

Designing intelligent systems

The expression swarm intelligence was first used by Beni, Hackwood, and Wang in the context of **cellular robotic systems**.

3.) Eric Bonabeau, Swarm Intelligence, 1999

The social insect metaphor for solving problems has become a hot topic in the last five years. The number of its sucessful applications is exponentially growing in **combinatorial optimization**, **communications networks** and **robotics**.

More and more researchers are interested in this new exciting way of achieving a form of artifical intelligence, swarm intelligence the **emergent collective intelligence of groups of simple agents**.
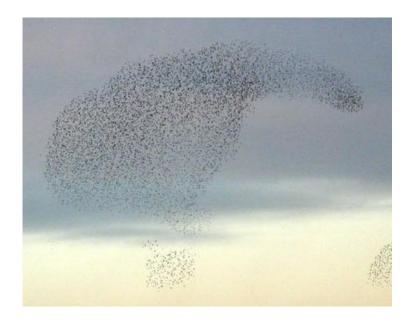
At a time when the world is becoming so complex that no single human being can understand it, when information is threatening our lives, when software systems become so intractable that they can no longer be controlled, swarm intelligence offers an alternative way of designing "**intelligent**" systems. [3.)]

Bird Flocking

A very influential simulation of bird flocking was published by Craig Reynolds in 1987. Reynolds asumed that flocking birds were driven by three local forces: **collision avoidance, velocity matching, and flock centering.**

- pull away before they **crash** into one another
- try to go the same **speed** as their neighbors in the flock
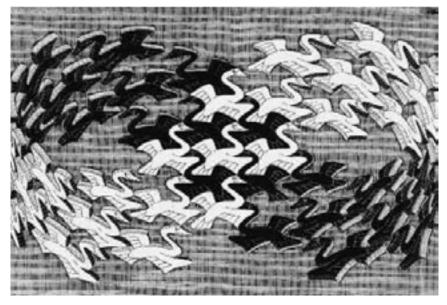- try to move toward the **center** of the flock as thes perceive it [4]

4.) James Kennedy, Russel C Eberhart, Swarm Intelligence, 2001

Benefits and Disadvantages of Swarm Systems

Benefits:
**Adaptable, Evolvable, Resilient,
Boundless and Novelty**

Apparent Disadvantages:
**Nonoptimal, Noncontrollable, Nonpredictable
Nonunderstandable and Nonimmediate** [5.]

5.) Kevin Kelly, Out of Control, 1997

M.C. Escher , Schwäne, 1956

Social Insects

The life cycle of a Honey bee

Unlike a bumble bee colony or a paper wasp colony the life of a honey bee colony is perennial.
There are three castes of honey bees:
queens, which produce eggs; **drones or males**, which mate with the queen and have no stinger; and **workers**, which are all non-reproducing females. [1]

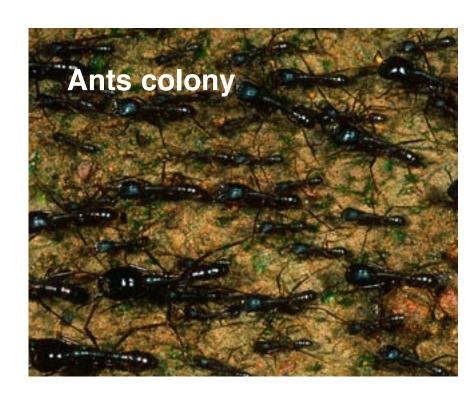The size of each group is regulated according to colony needs though some flow of **information** among them. [3]

Honey Bee

1.) From Wikipedia, the free encyclopedia

3.) Eric Bonabeau, Swarm Intelligence, 1999

Ants

A typical example of a natural swarm system is an **ant colony**.
Each ant follows only simple **local rules**, but through the interaction of a large number of ants, the colony as a whole acts like a **super-organism**:
it acquires food, competes for foraging areas, grows, and maintains a highly complex spatial as well as social organization. [2]

2.) Christian Jacob, Evolutionary and Swarm Design, 2001

Ants colony

Communication

There is some degree of **communication** among the ants, just enough to keep them from wandering off commpletely at random.

By this minimal communication they can remind each other that they are not alone but ate cooperating with teammates. It takes a **large number** of ants, all reinforcing each other this way, to sustain any activity - such as trail buiding-for any length of time. (Douglas Hofstadter, 1979) [4.]

4.) James Kennedy, Russel C Eberhart, Swarm Intelligence, 2001

Ants nest

Termites

Termites, sometimes known as **white ants**, are a group of eusocial insects usually classified at the taxonomic rank of order, Isoptera. Worker termites undertake the labours of foraging, food storage, brood, nest maintenance and some of the defense effort in certain species. [1]

Many aspect of the collective activities of social insects are **self organized**. [3]

1.) From Wikipedia, the free encyclopedia

3.) Eric Bonabeau, Swarm Intelligence, 1999

Termite

How do termites build their nests?

In some regions, notably arid tropical savannas, termites construct extremely large and elaborate **mounds** which house their colonies. These mounds can have very distinctive forms. [1]

It appears that the termits build a dome by taking some dirt in their mouths, moistening it, and folling these rules:
- Move in the direction of the strongest pheromone **concentration**.
- Deposit what you are carrying where the **smell** is strongest. [4]

1.) From Wikipedia, the free encyclopedia

4.) James Kennedy, Russel C Eberhart, Swarm Intelligence, 2001

Mounds

What is that governs here?

Every single insect in a social colony seems to have its own **agenda**, and yet an insect colony looks so **organized**.
What is that **governs** here?
What is it that issues orders, foresees the future, elaborates plans, and preserves equilibrium? [3]

3.) Eric Bonabeau, Swarm Intelligence, 1999

Beetle

How to connect individual behavior with collective performance?

An insect is a complex creature: it can process a lot of sensory inputs, modulate its behavior according to many stimuli, including interactions with nestmates, and make decisions on the basis of a large amount of information. [3]

3.) Eric Bonabeau, Swarm Intelligence, 1999

Human life

Communities

We humans are the most social of animals: we live together in **families**, **tribes**, **cities**,**nations**, behaving and thinking according to the rules and norms of our communities, adopting the customs of our fellows.
Even when we are alone, we think about other people, and even when we think about inanimate things, we think using language- the medium of interpersonal communication. [4.)]

4.) James Kennedy, Russel C Eberhart, Swarm Intelligence, 2001

Nomad

Communities of nomadic people **move from place to place**, rather than settling down in one location. Many cultures have been traditionally nomadic, but nomadic behaviour is increasingly rare in industrialised countries.
There are three kinds of nomads, hunter-gatherers, pastoral nomads, and peripatetic nomads.

Traffic congestion (Traffic Jam)

Traffic congestion is a road condition characterized by **slower speeds**, **longer trip times**, and increased queueing.
It occurs when roadway demand is greater than its capacity.

1.) From Wikipedia, the free encyclopedia

Rush hour

A rush hour (or peak hour) is a part of the day with **busy traffic** and hence traffic congestion on the roads and crowded public transport; normally the two periods in a day when people are travelling to or from work or school.

Game life

Sims

The Sims is a departure from most other computer games, which tend to have a definite goal or objective. Instead, the game focuses entirely on the **lives of virtual people** called „Sims," placing the player in control of their virtual „world", and their daily activities such as sleeping, eating, cooking and bathing, to name a few.

The inner structure of the game is actually an agent based **artificial life program**. [1]