**Project title:**
Developing advanced procedures in evolutionary computation paradigm and collective intelligence: Modelling, Simulation and Problem Solving

**Description:**
Natural intelligence is manufactured through evolution, and biological systems learn by doing and competing for survival without being told how to adapt to a specific environment. A very fundamental rule governs the entire process: the fittest species have an utmost opportunity to reproduce and thereby pass genetic material to the succeeding generation.

Decision theory, which is based on the axioms of probability and utility, has recently benefited from natural intelligence greatly. Nature-inspired algorithms like insect societies, evolutionary processes, swarm optimization, artificial immune systems and ant colony optimization have widely been recognized as mainstream of intelligent decision making.

The main idea of evolutionary approaches is to find the characteristics of high-quality solutions and to spread those characteristics in the entire population to improve the quality of solutions. Evolutionary methods, often referred to as population-based strategies, at each stage manipulate a collection of solutions rather than a single solution. In particular, this thesis is involved with developing efficient procedures in evolutionary computation and collective intelligence.

The following points are worth mentioning:
Evolutionary computation paradigm as a powerful trend in decision making is about co-operative problem solving, and collective intelligence is a branch of evolutionary computation. Swarm intelligence is another term referring to collective intelligence.

In analogy with evolutionary computation paradigm, a swarm is similar to population, and each of its members is similar to an individual. The use of population offers several conceptual advantages in the concepts of modelling, simulation, and problem solving. These advantages make possible the combination of promising features from a number of candidate solutions. The exciting feature of swarm performance is the fact that they demonstrate indications of very sophisticated collective behaviour despite the fact that individuals comprising the swarm are of absolute simplicity.

This sophistication is the result of interactions among swarm individuals by exchanging locally available information they have obtained. In general, a swarm can be defined as a group of simple agents which their implicit communication results in the emergence of high-quality decision making, changing loose local patterns into coherent global patterns. Members of a swarm can communicate with one another both directly and indirectly. However, tasks are performed without any central coordinator. This lack of central coordination is the main theme of the different problem solving methods developed in this PhD thesis.

**Specific Requirements for the candidate**: Familiarity with artificial intelligence, operations research and mathematical programming in advanced level.

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