Chapter 3
Cooperation of Nature and Physiologically Inspired Mechanisms in Visualisation

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ABSTRACT

A novel approach of integrating two swarm intelligence algorithms is considered, one simulating the behaviour of birds flocking (Particle Swarm Optimisation) and the other one (Stochastic Diffusion Search) mimics the recruitment behaviour of one species of ants – Leptothorax acervorum. This hybrid algorithm is assisted by a biological mechanism inspired by the behaviour of blood flow and cells in blood vessels, where the concept of high and low blood pressure is utilised. The performance of the nature-inspired algorithms and the biologically inspired mechanisms in the hybrid algorithm is reflected through a cooperative attempt to make a drawing on the canvas. The scientific value of the marriage between the two swarm intelligence algorithms is currently being investigated thoroughly on many benchmarks, and the results reported suggest a promising prospect (al-Rifaie, Bishop & Blackwell, 2011). It may also be discussed whether or not the artworks generated by nature and biologically inspired algorithms can possibly be considered as computationally creative.

INTRODUCTION

In recent years, studies of the behaviour of social insects (e.g. ants and bees) and social animals (e.g. birds and fish) have proposed several new metaheuristics for use in collective intelligence. Natural examples of swarm intelligence (a form of collective intelligence) that exhibit a form of social interaction are fish schooling, birds flocking, ant colonies in nesting and foraging, bacterial growth, animal herding, brood sorting etc.

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This chapter explores the artistic side of this collective intelligence, which emerges through the interaction of simple agents (representing the social insects/animals) in two nature-inspired algorithms, namely, Particle Swarm Optimisation (PSO) (J. Kennedy & Eberhart, 1995) and Stochastic Diffusion Search (SDS) (Bishop, 1989). Additionally, the mechanisms of blood vessel and blood flow are utilised to add another layer of detail to the drawing.

In the presented work, a user-made sketch is used as an input for the system. Then, the swarms of 'birds' and 'ants' explore the digital canvas they are provided with, going through all the lines made in the sketch and reworking them in their own way. The output of the system would be the swarms' 'interpretation' of the original sketch. As mentioned earlier, at a later stage, the physiologically inspired mechanism of blood flow is also used to add more details to the drawings made by the swarms.

A-Life (Artificial Life), where the boundary between biology and artificial intelligence is blurred (Levy, 1993), inspired many artists and researchers in computer graphics to explore this blurred area. Among the direct responses to A-Life are some works by Karl Sims (e.g. Sims, 1991, 1994). In an earlier work, Harold Cohen, an artist who used techniques of artificial intelligence to produce art, developed a computer program called AARON, which produced drawings as well as paintings (McCorduck, 1991).

Following other works in the field of swarm painting (Moura & Ramos, 2007, Aupetit, Bordeau, Monmarche, Slimane, & Venturini, 2004, Urbano, 2005, 2006) and ant colony paintings (Greenfield, 2005, Monmarche, Aupetit, Bordeau, Slimane, & Venturini, 2003), this work, in addition to exhibiting the cooperation of birds and ants as a new way in making a drawing, benefits from the mechanism used in blood vessels.

There are many works where the input of the nature has been utilised, some of which *are* claimed be to art. As for the presented work, despite the novelty of this hybrid approach, it is not the intention of the authors to use the results outlined in this work to make neither strong epistemological claims of computational creativity nor strong aesthetic claims of style.

In this chapter, each of the swarm intelligence algorithms used are introduced, and an approach to their possible integration is highlighted. Subsequently, the simplified mechanisms of blood vessel and blood flow are described, followed by an explanation on how the new hybrid algorithm produces a drawing and the role played by blood vessel remodeling. Lastly, the similar individualistic approach of the swarms in making a drawing is highlighted, followed by a brief section on creativity in general as well as a discussion on whether swarms can be computationally creative. The chapter comes to an end with a conclusion and possible future research.

BACKGROUND

After a brief introduction to communication in social systems, this section introduces two swarm intelligence algorithms as well as their integration strategy, followed by the simplified mechanism of blood vessel and blood flow.

Communication in Social Systems

Communication – social interaction or information exchange – observed in social insects and social animals plays a significant role in all swarm intelligence algorithms, including SDS and PSOs. Although in nature not just the syntactical information is exchanged between the individuals but also semantic rules and beliefs about how to process this information (J. F. Kennedy, Eberhart, & Shi, 2001), in typical swarm intelligence algorithms only the syntactical exchange of information is taken into account.

In the study of the interaction of social insects, two important elements are the individuals and the environment, which result in two integration schemes: the first one is the way in which indi-