Chapter 3.25
Particle Swarms:
Optimization Based on Sociocognition

James Kennedy
U.S. Department of Labor, USA

ABSTRACT

Particle swarm optimization is a computer paradigm that is based on human social influence and cognition. Candidate problem solutions are randomly initialized, and improvements are found through interactions among them. Social-psychological aspects of the algorithm are described, followed by implementation details. The particle swarm operates in three kinds of spaces, namely a topological space comprising the "social network" structure of the population, a parameter space of problem variables, and a one-dimensional evaluative space. Variations in the algorithm are described, and finally it is compared to evolutionary computation models.

INTRODUCTION

This chapter introduces the particle swarm algorithm, which is used to optimize hard problems. The algorithm is sometimes compared to evolutionary algorithms (EAs) of various sorts, as it comprises a population of individuals and random fluctuation, which are characteristic of EAs. The particle swarm arose from research in social psychology, and differs significantly from evolutionary methods. This chapter develops the algorithm from the sociocognitive perspective, describes some variations of the algorithm, and finally draws comparisons between particle swarms and related paradigms.

Mind and Logic

There is not only a close analogy between the operations of the mind in general reasoning and its operation in the particular science of Algebra, but there is to a considerable extent an exact agreement in the laws by which the two classes of operations are conducted. (Boole, 1854, p. 6)

George Boole's volume, *An Investigation into the Laws of Thought, on Which are founded the Mathematical Theories of Logic and Probabilities*, assumed, even in the title, that human thought was rational, that our minds obeyed the

laws of logic, and that once these were properly understood, the mind itself would be explained (Boole, 1854). *Logic.* The word is chilling, the process cuts like a fast-moving razor, deducing, deciding, pressing forward relentlessly, freezing the vermin of vagueness in the cold light of truth. It always seemed that, if the rules were just known, if we only understood a little better how a conclusion follows from a premise, and under what conditions — given the correct premises, we should be able to master all knowledge and happily live out the utopian dream.

The computer changed all that. Finally, with the invention of the electronic computer, the laws of reason that had been well established over the millennia could be implemented in a machine; pure logical processes could run all on their own, without dirty, disorganized, *biological,* humans to mess it all up with egocentric, biased, wishful thinking.

And guess what: it didn't work.

The first "artificial intelligence" programs were great for solving well-defined mathematical and logical problems, but the dreams of exceeding or even challenging human intelligence just never materialized. Even though some hard things, such as theorem-proving, were fairly easy to accomplish, it turned out that the easy things are too hard. Picking out a friend in a crowd; interpreting language (which any four-year-old can do); walking and chewing gum, separately or at the same time — these ordinary things, it was discovered, were extremely hard for a machine to do.

There is irony of course in the fact that the quest of civilized intellect arrives at the realization that the goal was not worth striving for. Pure logical reasoning, it turns out, is extremely limited, too weak to handle the interesting challenges of a normal day, never- mind the complex dimensions of real engineering problems. The elusive quality we call intelligence has a logical component—ability to reason is an important part of any IQ test for humans—but we find that perfect crisp logic as instantiated in the von Neumann computer is an inert and sterile capacity.

The Sociocognitive Solution

So it is time to look somewhere else for techniques, if we want to use the computer to find solutions to nasty, gnarly problems. In keeping with the theme of this volume, this chapter recommends that we look for techniques in a really successful biological system, a system that has improved itself over time, and that has resulted in the almost-too-good reproductive success of a species. I am talking about human social behavior.

This chapter will describe a computational problem-solving or optimization method that is based on a social psychological description of human behavior. Social psychology is the empirical study of the individual in his or her social context. Being a topic within psychology, it investigates the effects of interpersonal relationships, group processes, conformity, social influence and persuasion, self-presentation and impression formation, perception and cognition of other people, attribution of causes of behavior, and other facets of the interface between the person and the community. Being empirical, it derives its conclusions from careful experimentation with human subjects.

While there is no single unified "social-psychological view" or theory, social psychologists tend to regard cognition in relation to interpersonal processes. For instance, an individual's beliefs are easily shown to correlate with the beliefs of the people he or she knows, and there are two explanations for this: people gravitate toward those who seem similar to themselves (Byrne, 1971), and people change to become more like the people they interact with (Latané, 1981).

It is not hard to see how people could change to resemble their peers. For instance, many conversations can be best typified as attempts by two people to persuade one another that their beliefs and opinions are correct. I tell you what I think, you tell me what you think, and sometimes we will, in fact, convince one another of something. Over time, recurrences of this kind of event will

Related Content

A Fuzzy Clustering Model for Fuzzy Data with Outliers

M. H. Fazel Zarandiand Zahra S. Razaee (2011). *International Journal of Fuzzy System Applications (pp. 29-42).*

www.irma-international.org/article/fuzzy-clustering-model-fuzzy-data/54240

Indirect Adaptive Fuzzy Control for a Class of Uncertain Nonlinear Systems with Unknown Control Direction

Salim Labiod, Hamid Boubertakhand Thierry Marie Guerra (2011). *International Journal of Fuzzy System Applications (pp. 1-17).*

www.irma-international.org/article/indirect-adaptive-fuzzy-control-class/60377

Performance Analysis of DE over K-Means Proposed Model of Soft Computing

Kapil Patidar, Manoj Kumarand Sushil Kumar (2017). *Artificial Intelligence: Concepts, Methodologies, Tools, and Applications (pp. 2294-2307).*

www.irma-international.org/chapter/performance-analysis-of-de-over-k-means-proposed-model-of-soft-computing/173425

Optimal Strategy for the Smartphone Industry in Taiwan: HTC Case Study

Yi-Fen Chen, Bi-Chu Chen, Wen-Yu Chen, Chia-Wen Tsaiand Wei-Hung Lin (2012). *International Journal of Intelligent Information Technologies (pp. 62-79).*

www.irma-international.org/article/optimal-strategy-smartphone-industry-taiwan/74830

Self-Adaptive ReLU Neural Network Method in Least-Squares Data Fitting

Zhiqiang Caiand Min Liu (2024). *Principles and Applications of Adaptive Artificial Intelligence (pp. 242-262).*

www.irma-international.org/chapter/self-adaptive-relu-neural-network-method-in-least-squares-data-fitting/337696