Chapter 6
An Incremental Evolutionary Approach to Tabu Search

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ABSTRACT

Based on recent viral transmission events in the swine species, we present a new framework to implement and execute tabu search (TS). The framework mimics the gradual evolutionary process observed when certain flu viruses move from one host population to another. It consists of three steps: (1) executing TS on a smaller subset of the original problem, (2) using one of its promising solutions as an initial solution for a marginally larger problem, and (3) repeating this process until the original problem is reached and solved. Numerical experiments conducted with randomly-generated vehicle routing instances demonstrate interesting results.

INTRODUCTION

Tabu search (TS) is one of the most widely used metaheuristics in practice and academic research, especially for solving difficult combinatorial problems (e.g., traveling-salesman, vehicle routing, sequencing, network-design, and spanning tree problems) (Toth & Vigo, 2003). Past studies have investigated the question of how...
to improve the effectiveness (solution quality) and efficiency (solution speed) of TS
by exploring a variety of diversification and intensification strategies, neighborhood
definitions, tabu-list updating procedures, and termination criteria (Ho, Shiyou, Ni,
& Wong, 2001; Gendreau & Potvin, 2010). To the best of our knowledge, however,
none of these past studies have explored the question of how the TS performance
can be improved by changing the nature (e.g., size) of the problem during the
optimization run. Changing the problem characteristics during the optimization
run can be potentially beneficial, as it can provide the information that would be
difficult to obtain under the conventional TS execution method (where the nature
of the problem is fixed), which may be used to enhance the TS performance. We
investigate a new way of executing TS that changes the nature of the problem dy-
namically during the optimization run, and contrast its performance with that of a
well-known TS procedure.

BASIC IDEA AND RELATED LITERATURE

General Idea

The basic idea of our approach (framework) is inspired by the viral transmission
incidents observed between swine (pig) and avian (bird) flues several years ago.
These incidents showed that while influenza A virus (bird flu) in its original form
can hardly infect human beings, it can transform itself into a new form which can
pose threats to humans if it goes through pigs. In other words, while moving directly
from birds to humans is an infeasible path for the flu, moving indirectly from birds
to humans through pigs is a feasible path (see Figure 1). This means that, although a
virus residing in one environment (E$_1$) cannot move to a very different environment
(E$_M$) directly, it may be able to eventually transform itself into a new form that can
reside in E$_M$ if, for example, it goes through an indirect transmission path: E$_1$ → E$_2$
→ ... → E$_m$ → E$_{m+1}$ → ... → E$_M$, where E$_m$ and E$_{m+1}$ represent different, but similar,
living environments (hosts populations) for the virus. Our approach is based on this
idea of sequential (and gradual) viral transmission and evolution.

Related Literature

A limited number of studies have developed algorithms that involve the emulation
of viral movements among host populations, most of which relied on the use of
genetic algorithms (GAs). Arakawa et al. (1996) implemented a virus-based GA
to the trajectory generation problem, particularly with application to robotics. The
algorithm divides the population into several subpopulations (virus and host popu-
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