A Comparison of Continuous Genetic Algorithm and Particle Swarm Optimization in Parameter Estimation of Gompertz Growth Model

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Abstract. Genetic algorithm and Particle Swarm Optimization are heuristic optimization methods inspired by genetic principles and swarm behavior phenomena, respectively. Those two methods are initiated by random generation of initial populations (initial solutions), fitness evaluation of every solution, solution updating until a termination condition are met. It is well known that those two methods are not always converge to an optimal solution. Those methods sometimes converge to suboptimal solutions, solution near the optimal solution. In this paper, continuous genetic algorithm and particle swarm optimization were implemented to estimate parameters in the Gompertz growth model from rooster weight data cited from literature. Although the best results of the two models were not significantly differs, we found that the particle swarm optimization method was more robust than the continuous genetic algorithm. Hence, the particle swarm optimization method is more recommended than the continuous genetic algorithm.

Keywords: Gompertz growth model, rooster weight dynamic, parameter estimation, particle swarm optimization.

INTRODUCTION

Mathematical models are useful tool to describe many real problems. A mathematical model is usually began by identification of a real problem. Then one could construct a suitable mathematical model and determining mathematical solution of the model. Finally, one should interpret mathematical solution of the model into real problem points of view. A mathematical model might occur in either a deterministic model or a probabilistic (stochastic) model. Mathematical model validation could be performed whenever relevant data from real phenomena are available. If the predicted results from a mathematical model fit the real data, then the model is said a good model. When the predicted results from the model differ significantly the real data, then the model should be improved and modified.

Most mathematical models contain one or more parameters. The parameters should be estimated in order to accurately perform model simulation. Parameter estimation of a mathematical model could be considered as an optimization problem. Deterministic optimization methods such as conjugate gradient method, Nelder-Mead method or Newton method could be applied to estimate parameters in a mathematical model whenever analytical solution of the model could be presented in closed form [1]. Unfortunately, deterministic optimization methods such as Nelder-Mead or Newton method fail to converge into global minimum of a function if the function has many local minima [2]. Moreover, some mathematical models occur in non-linear ordinary differential equation systems, so exact solution (closed form solution) of the model could not be determined. In this case, heuristic method such as particle swarm optimization and genetic algorithm method could be implemented to estimate parameter values from the models.

Particle swarm optimization and genetic algorithm are optimization methods based on a population-based stochastic search process [3, 4]. Particle swarm optimization methods and modified particle swarm optimization have been widely applied in many areas, including performance improvement of Artificial Neural Network [5, 6], scheduling problems [7, 8], flowshop scheduling problem [9], traveling salesman problem [10], vehicle routing problem [11, 12] and clustering technique [13]. Genetic algorithm has been in parameter estimation in poultry growth model [14, 15] and parameter estimation for dynamical system model [1, 16].

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