BSKF: Binary Simulated Kalman Filter

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***Abstract*—Inspired by the estimation capability of Kalman filter, we have recently introduced a novel estimation-based optimization algorithm called simulated Kalman filter (SKF). Every agent in SKF is regarded as a Kalman filter. Based on the mechanism of Kalman filtering and measurement process, every agent estimates the global minimum/maximum. Measurement, which is required in Kalman filtering, is mathematically modelled and simulated. Agents communicate among them to update and improve the solution during the search process. However, the SKF is only capable to solve continuous numerical optimization problem. In order to solve combinatorial optimization problems, an extended version of SKF algorithm, which is termed as Binary SKF (BSKF), is proposed. Similar to existing approach, a mapping function is used to enable the SKF algorithm to operate in binary search space. A set of traveling salesman problems are used to evaluate the performance of the proposed BSKF against Binary Gravitational Search Algorithm (BGSA) and Binary Particle Swarm Optimization (BPSO).**

Keywords-simulated kalman filter; traveling salesman problem; combinatorial optimization

I. INTRODUCTION

There are various meta-heuristic algorithms exist in literature nowadays. However, not all meta-heuristic algorithms were originally developed to operate in binary search space. An example of this algorithm is simulated Kalman filter (SKF), which has been recently introduced by Ibrahim *et al.* in 2015 [1]. The SKF is a population-based optimization algorithm that is inspired by the estimation capability of Kalman filter. In order to solve discrete optimization problems with SKF, modification or enhancement is needed. An example of such modification is by using a sigmoid function as a mapping function to let particle swarm optimization (PSO) to operate in binary search space [2].

The objective of this study is to extend the SKF algorithm for solving combinatorial optimization problem. Similar to existing works, a mapping function is employed to enable the SKF algorithm to operate in binary search space.

This paper is organized as follows. At first, SKF will be briefly reviewed followed by a detail description of the proposed Binary SKF (BSKF) algorithm. Experimental set up will be explained, results will be shown and discussed. Lastly, a conclusion will be provided at the end of this paper.

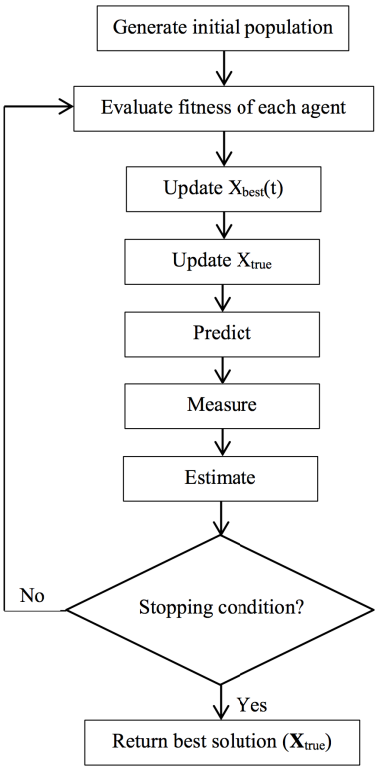

Figure 1. The original simulated Kalman filter (SKF) algorithm.

II. SIMULATED KALMAN FILTER

Every agent in SKF is regarded as a Kalman filter. Based on the mechanism of Kalman filtering and measurement process, every agent estimates the global minimum/maximum. Measurement, which is required in Kalman filtering, is mathematically modelled and simulated. Agents communicate among them to update and improve the solution during the search process. The simulated Kalman filter (SKF) algorithm is illustrated in Figure 1.

Consider n number of agents, SKF algorithm begins with initialization of n agents, in which the states of each agent are given randomly. The maximum number of iterations, t_{max}, is defined. The initial value of error covariance estimate, $P(0)$, the process noise value, Q, and the measurement noise value, R, which are required in Kalman filtering, are also defined during initialization stage.