International Journal of Innovative Computing, Information and Control
Volume **8**, Number **5(B)**, May **2012**

ICIC International ©2012 ISSN 1349-4198
pp. 3441–3450

DNA SEQUENCE DESIGN FOR DNA COMPUTATION BASED ON BINARY PARTICLE SWARM OPTIMIZATION

Zuwairie Ibrahim[1], Noor Khafifah Khalid[2], Salinda Buyamin[2]
Ismail Ibrahim[2], Jameel Abdulla Ahmed Mukred[2], Zulkifli Md. Yusof[2]
Mohd Saberi Mohamad[3], N. Mokhtar[4], Muhammad Faiz Mohamed Saaid[4]
and Andries Engelbrecht[5]

[1]Faculty of Electrical and Electronic Engineering
Universiti Malaysia Pahang
26600 Pekan, Pahang, Malaysia
zuwairie@fke.utm.my

[2]Faculty of Electrical Engineering
[3]Faculty of Computer Science and Information Systems
Universiti Teknologi Malaysia
81310 Skudai, Johor, Malaysia
{ salinda; jameel; zmdyusof }@fke.utm.my
ifah.khalid@gmail.com; ismail_xyz@yahoo.com; saberi@utm.my

[4]Faculty of Engineering
University of Malaya
50603 Kuala Lumpur, Malaysia
{ norrimamokhtar; mfms }@um.edu.my

[5]Department of Computer Science
University of Pretoria
Pretoria 0028, South Africa
engel@cs.up.ac.za

Received November 2010; revised March 2011

Abstract. *Deoxyribonucleic Acid (DNA) has certain unique properties such as self-assembly and self-complementary in hybridization, which are important in many DNA-based technologies. DNA computing, for example, uses these properties to realize a computation in vitro, which consists of several chemical reactions. Other DNA-based technologies such as DNA-based nanotechnology and polymerase chain reaction also depend on hybridization to assemble nanostructure and to amplify DNA templates, respectively. Hybridization of DNA can be controlled by properly designing DNA sequences. In this paper, sequences are designed such that each sequence uniquely hybridizes to its complementary sequence, but not to any other sequences. Objective functions involved are similarity, $H_{measure}$, continuity, and hairpin. Binary particle swarm optimization (BinPSO) is employed to minimize those objectives subjected to two constraints: melting temperature and $GC_{content}$. It is found that BinPSO can provide a set of good DNA sequences, better than basic PSO algorithm in terms of aggregated fitness value.*
Keywords: Particle swarm optimization, Binary PSO, DNA sequence design, Optimization

1. **Introduction.** Deoxyribonucleic acid (DNA) is a nucleic acid that contains the genetic instructions used in the development and functioning of all known living organisms and some viruses. However, DNA molecules are presently used in many areas far beyond its traditional function. In 1994 for example, a DNA-based computation has been introduced by Adleman [1] to solve a Hamiltonian path problem (HPP). The success of the