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ORIGINAL ARTICLE

# A hybridization of butterfly optimization algorithm and harmony search for fuzzy modelling in phishing attack detection

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**Abstract**
Fuzzy system is one of the most used systems in the decision-making and classification method as it is easy to understand because the way this system works is closer to how humans think. It is a system that uses human experts to hold the membership values to make decisions. However, it is hard to determine the fuzzy parameter manually in a complex problem, and the process of generating the parameter is called fuzzy modelling. Therefore, an optimization method is needed to solve this issue, and one of the best methods to be applied is Butterfly Optimization Algorithm. In this paper, BOA was improvised by combining this algorithm with Harmony Search (HS) in order to achieve optimal results in fuzzy modelling. The advantages of both algorithms are used to balance the exploration and exploitation in the searching process. Two datasets from UCI machine learning were used: Website Phishing Dataset and Phishing Websites Dataset. As a result, the average accuracy for WPD and PWD was 98.69% and 98.80%, respectively. In conclusion, the proposed method shows promising and effective results compared to other methods.

**Keywords** Fuzzy · Butterfly optimization algorithm · Harmony search · Phishing detection

## 1 Introduction

Cyber security has always been a concern in the world of advanced technology, where one can access anything at their fingertips. The more advanced the technology, the smarter the cyber criminals can be. A cyber threat is a malicious act or attempt by cyber criminals to damage or steal data and gain control of computer systems with bad intentions. The phishing attack is one of the most common cybersecurity threats in line with smishing conducted via emails, texts and phone calls [1]. Phishing is an action that usually uses social engineering to steal a user's private information by fooling the user into clicking on a suspicious-looking link that seems real to the user. Such attacks enable phishers or cyber criminals to steal user login accounts or personal financial information. Figure 1 illustrates the process of the phishing attack through the website.

Many actions have been taken to deal with this never-ending cyber threat issue. Many researchers have introduced various methods and applications to detect phishing which presents a major threat in security networks [2–4]. As the year passes, an improvement should be done to the existing method to improve the efficiency of detecting phishing. According to [5], the fuzzy system is one of the best decision-making methods. It has the advantage of indicating data with no statistical uncertainties and has been applied in various fields such as science and engineering [6]. Basically, fuzzy logic seems closer to how our brain functions. It has the advantage that the human operators can understand it better in order to solve the problems.

Fuzzy is a rule-based model in which the source of information of the fuzzy system is various knowledge and data. There are three ways that fuzzy sets can be included in a system [7]. The first one is in the description of the system. A system can be clarified as a collection of if–then rules with fuzzy relations. The next way is in the specification of the system's parameter, in which the parameters

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