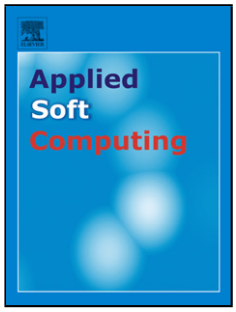

Title: Multi-Objective Ensemble Forecasting with an Application to Power Transformers

Author: Abdolrahman Peimankar Stephen John Weddell Thahirah Jalal Andrew Craig Lapthorn

PII: S1568-4946(18)30165-0
DOI: https://doi.org/doi:10.1016/j.asoc.2018.03.042
Reference: ASOC 4791

To appear in: *Applied Soft Computing*

Received date: 10-8-2017
Revised date: 23-1-2018
Accepted date: 23-3-2018

Please cite this article as: Abdolrahman Peimankar, Stephen John Weddell, Thahirah Jalal, Andrew Craig Lapthorn, Multi-Objective Ensemble Forecasting with an Application to Power Transformers, *<![CDATA[Applied Soft Computing Journal]]>* (2018), https://doi.org/10.1016/j.asoc.2018.03.042

Multi-Objective Ensemble Forecasting with an Application to Power Transformers

Abdolrahman Peimankar[a,*], Stephen John Weddell[a], Thahirah Jalal[b], Andrew Craig Lapthorn[a]

[a] *Department of Electrical and Computer Engineering, University of Canterbury, Christchurch 8041, New Zealand*
[b] *Unison Networks Limited, Hastings 4156, New Zealand*

Abstract

In this paper we present an ensemble time series forecasting algorithm using evolutionary multi-objective optimization algorithms to predict dissolved gas contents in power transformers. In this method, the correlation between each individual dissolved gas and other transformers' features such as temperature characteristics and loading history is first determined. Then, a non-linear principal component analysis (NLPCA) technique is applied to extract the most effective time series from the highly correlated features. Afterwards, the forecasting algorithms are trained using a cross validation technique. In addition, evolutionary multi-objective optimization algorithms are used to select the most accurate and diverse group of forecasting algorithms to construct an ensemble. Finally, the selected ensemble is examined to predict the value of the dissolved gases on the testing set. The results of one day, two day, three day, and four day ahead forecasting are presented which show higher accuracy and reliability of the proposed method compared with other statistical methods.

Keywords: Ensemble learning, evolutionary algorithms, multi-objective optimization, time series forecasting, power transformers

1. Introduction

One of the key components in electric power system networks is power transformers and to deliver reliable electricity it is very important to maintain them properly. Replacing a power transformer is expensive and a unit can cost up to 1 million dollars. As a consequence, long lead times and loss of supply are typical [1, 2]. So, electric utilities and power companies can schedule optimum maintenance plans and prevent their transformers from failure and widespread power outage in the network. There are various condition monitoring and condition assessment techniques for these types of assets [3, 4]. Dissolved Gas Analysis (DGA) is a well-known technique which is used by electric utilities and power companies to assess the condition of power transformers using values and trends of the dissolved gases [5]. DGA is performed on the transformers' oil and measures the main hydrocarbons dissolved gases such as hydrogen (H_2), methane (CH_4), acetylene (C_2H_2), ethylene (C_2H_4), ethane (C_2H_6), carbon dioxide (CO_2), and carbon monoxide (CO). There are methods and standards that use values and different ratios of these gases to diagnose incipient faults of transformers [6, 7, 8]. Therefore, forecasting the value of the dissolved gases

*Corresponding author
Email address: abdolrahman.peimankar@pg.canterbury.ac.nz (Abdolrahman Peimankar)