

电力用户异常用电的深度神经网络检测方法

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Deep neural network detection method for abnormal electricity consumption by power users

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摘要:以电力用户异常用电为代表的电力系统非技术性损耗通常会造成供电公司运营成本的显著性上升。首先,提出一种电力用户异常用电的深度神经网络检测方法,根据电力用户用电负荷特性采用深度置信网络(DBN)对原始的电力负荷数据进行特征提取并获取符合特征,其次,基于极限学习机(ELM)完成特征分类,从而建立电力用户异常用电检测基础模型。最后,提出一种采用改进果蝇优化算法(IFOA)对DBN的网络权重与层间偏置参数进行寻优,由此获得基于IFOA-DBN-ELM的电力用户异常用电检测模型。实验结果表明:所提方法的准确率、精确度和检出率显著高于其他方法,误检率低于其他方法,能够较为准确地检测出具有异常用电行为的电力用户,有助于降低供电公司的运营成本。

关键词:异常用电;深度置信网络;极限学习机;果蝇优化算法;电力用户

Abstract: Non technical losses in power systems, represented by abnormal electricity consumption by power users, will typically result in significant increase in the operating costs of power supply companies. Firstly, deep neural detection method for abnormal electricity consumption by power users is proposed. Based on the characteristics of electricity consumption by power users, a deep confidence network (DBN) is used to extract features from the original electricity load data and obtain corresponding features. Then, feature classification is completed using an extreme learning machine (ELM), thus establishing a basic model for detecting abnormal electricity consumption by power users. Finally, an improved fruit fly optimization algorithm (IFOA) to optimize the network weights and inter layer bias parameters of DBN is proposed, thereby obtaining an abnormal electricity consumption detection model for power users based on IFOA-DBN-ELM. Experimental results show that compared with other detection methods, the accuracy, precision, and detection rate of the method proposed are significantly higher, and false detection rate are lower than other methods. It can accurately detect power users with abnormal electricity consumption behavior and help reduce the operating costs of power supply companies.

Key words: abnormal power consumption; deep confidence network; extreme learning machine; fruit fly optimization algorithm; power users

0 引言

随着国家“碳达峰”和“碳中和”目标的提出,电力系统的节能降耗已经逐步纳入供电企业未来发展的规划中。电力系统运行过程中的能量损耗可以划分为技术性损耗(technical loss, TL)以及与之对应的非技术性损耗(non-technical loss, NTL)^[1]。当前由于NTL引起的供电企业电能损耗往往会导致数额不菲的经济损失,其具体呈现形式为电力用户的异常用

电,包括窃电与欺诈等不道德行为,极大地危害了供电企业的利益。因此,合理高效的控制电网的NTL,是供电企业完成节能降耗,降低公司运营成本,提升企业经济效益的必由之路^[2]。

对NTL实现高效准确的检测是当前电力企业发展过程中的重点研究方向。当前供电公司主要从技术层面和数据层面应对出现的NTL情况^[3-4]。其中技术层面主要是通过对计量装置等进行技术升级来遏制电力用户的异常用电行为。而数据层面则是通过对少量电力用户用电数据样本进行数据分析来检测潜在的异常用电行为。随着计算机技术的不断进步,在电力用户异常用电检测领域也

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