UDC 004.273

FUZZY LOGIC USAGE FOR THE DATA PROCESSING IN THE INTERNET OF THINGS NETWORKS

Kurdecha V.V., Ishchenko I.O., Zakharchuk A.G. Kunieva N.V.
Institute of Telecommunication Systems,
Igor Sikorsky Kyiv Polytechnic Institute, Ukraine
E-mail: ivanishchenkoo@gmail.com

ВИКОРИСТАННЯ НЕЧІТКОЇ ЛОГІКИ ДЛЯ ОБРОБКИ ДАНИХ У МЕРЕЖАХ ІНТЕРНЕТУ РЕЧЕЙ

Перевантажена мережа Інтернету Речей потребує обробки даних для аналізу залежності стану системи від вхідних параметрів. При роботі з великими обсягами даних вже недостатньо простого та статистичного аналізу даних. Метою роботи є визначення найбільш ефективного методу кластеризації для систем, які призначені для визначення якості зв'язку, за рахунок проведення аналізу існуючих методів кластеризації у нечітких системах. В статті розглянуто різні типи кластеризації нечітких систем, які підходять до використання в різних телекомунікаційних систем. У результаті аналізу алгоритм нечітких с-середніх вибрано як найефективнішим за критерієм обчислювальної складності, для кластеризації у мережах визначення якості зв'язку.

An overloaded Internet of Things (IoT) network needs data processing to analyses the state of the system from the input parameters. When working with large volumes of data, there is not enough simple and statistic data analysis. The purpose of the work is to determine the most effective clustering method for systems that are intended to determine the quality of the connection by analyzing existing cauterization methods in fuzzy systems. In the article various types of clustering of fuzzy systems that are suitable for use in various telecommunication systems are considered. As a result of the analysis, the algorithm c-means is selected as the most effective by the criterion of computational composition, for clustering in the networks of determining the quality of communication.

Modern computing and distributed information systems (for example, cloud computing systems, networks based on the dynamic architectures of VANET and MANET, smart-type networks, intelligent controllers and sensors networks, etc.) are complex telecommunication networks that include many different types of network devices, which are integrated into a single information and computing block, work with high network load. These networks are sources of large volumes of data and they support a large number of reconfigurable connections. An overloaded Internet of Things (IoT) network needs data processing to analyses the state of the system from

the input parameters.

A huge data sets in the IoT networks

For the implementation of the Internet of Things systems, we need to further develop specialized methods put forward for such systems. Goals that can be used for verification and transmitted in accordance with the rules included in the system. The usual mathematical methods are too complicated for IoT systems, so there is a need for simpler algorithms that can provide the quality of the received technical solutions. In addition, it is important that during the adoption of IoT systems, it is often not possible to use Boolean logic, because sometimes it is not possible to describe the system parameter with two possible states [2].

The usage of cluster analysis algorithms is aimed at dividing the set of data into clusters so that each of them has the closest objects [3]. Fuzzy clustering is one of the most interesting methods for identifying possible groups and testing hypotheses about the data structure. There are a number of clustering techniques. The main methods of fuzzy clustering: fuzzy decision trees, fuzzy Petri nets, fuzzy self-organizing maps [4].

Algorithm of fuzzy self-organization c-means

Purpose: clustering large sets of numeric data.

Advantages: fuzzy when assigning objects to the cluster, allows you to identify objects that are on the border of the cluster.

Disadvantages: computational complexity, specifying the number of clusters at the input of the algorithm, there is uncertainty with objects that are significantly removed from the centers of all clusters.

In the classical algorithm of k-means (c-means), elements are chosen using the ordinary Euclidean distance between the vector x and the center of the cluster c. In this case, the quality of clustering can be significantly improved by using an improved version of the self-organization algorithm, which is called the Gustavsson-Kessel algorithm.

Fuzzy decision trees

Fuzzy decision trees are used in Data Mining to solve classification problems and to solve the regression problem when it is necessary to know the degree of belonging to a particular outcome [5]. They can be used in various fields: in banking for solving the problem of scoring, in medicine for diagnosing various diseases, in the industry for quality control of products and so on.

Unconditional advantage of this approach is the high accuracy of classification achieved by combining the advantages of fuzzy logic and decision trees. The learning process takes place quickly, and the result is simple for interpretation. Since the

algorithm is capable of issuing for the new object not only the class, but also the degree of belonging to it, it allows to control the classification threshold.

Fuzzy Petri nets

In the Petri time networks, conditions are represented by a set of positions, and their execution is represented by marking the corresponding position [5]. Auxiliary reduction methods are used, which make it possible to reduce the size of the Petri net while preserving its properties, and the decomposition that divide the source network into subnets. A feature of Petri nets is the possibility of presenting fuzzy processes and the dynamics of their interaction. The disadvantage is that many parameters, indicators and characteristics are not taken into account, without which it is difficult to imagine the real processes of practical implementations.

CONCLUSION. All of the considered algorithms have a common disadvantage of the algorithm complexity and this is very important as the IoT network has a rigid frame of time delays in processing information, obtaining conclusions, etc. Because of this problem, an approach is taken to form the basis of fuzzy knowledge base which allows using previously obtained knowledge about the behavior of the system or process, which allows us to do the analysis of data based on certain rules.

Thus, the analysis of the mathematical methods of data analysis that can be carried out in IoT systems allows us to consider that different data analysis methods allow you to obtain different data, which in turn are close to real ones, which is evidence that all these algorithms can be used in different systems. The algorithm c-means is selected as the most effective by the criterion of computational composition, for clustering in the networks of determining the quality of communication.

References

1. R. Lea, M. Blackstock, Smart cities: An iot-centric approach, in: Proceedings of the 2014 International Workshop on Web Intelligence and Smart Sensing, IWWISS'14, ACM, NewYork, NY, USA, 2014, pp.12–15.
2. M. Nikravesh, Evolution of fuzzy logic: From intelligent systems and computation to human mind, Stud. Fuzziness Soft Comput. 2007, pp. 37–53.3. J. G. Proakis, Digital Communication, 4th ed. Boston, MA: McGraw-Hill, 2000.
3. G. Cueva-Fernandez, J. Pascual Espada, V. Garc´ıa-D´ıaz, R. Gonzalez Crespo, Fuzzy decision method to improve the information exchange in a vehicle sensor tracking system, Appl. Soft Comput. 2015, pp. 708–716.
4. Sugeno M., Yasukawa T. A fuzzy-logic-based approach to qualitative modeling // IEEE Trans. on Fuzzy Systems, 1993, vol. 1, pp. 7–31.
5. Emami M.R., Turksen I.B., Goldenberg A.A. A unified parameterized formulation of reasoning in fuzzy modeling and control // Fuzzy Sets and Systems, 1999, vol. 108, pp. 59–81.