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Chapter 7
Clustering and Principal Feature Selection
Impact for Internet Traffic Classification
Using K-NN

Trianggoro Wiradinata and P. Adi Suryaputra

Abstract  K-NN is a classification algorithm which suitable for large amounts of data and have higher accuracy for internet traffic classification, unfortunately K-NN algorithm has disadvantage in computation time because K-NN algorithm calculates the distance of all data in some dataset. This research provide alternative solution to overcome K-NN computation time, the alternative solution is to implement clustering process before the classification process. Clustering process does not require high computation time. Fuzzy C-Mean algorithm is implemented in this research. The Fuzzy C-Mean algorithm clusters the based datasets that be entered. Fuzzy C-Mean has disadvantage of clustering, that is the results are often not the same even though the input data are same, and the initial dataset that of the Fuzzy C-Mean is not optimal, to optimize the initial datasets, in this research, feature selection algorithm is used, after selecting the main feature of dataset, the output from fuzzy C-Mean become consistent. Selection of the features is a method that is expected to provide an initial dataset that is optimum for the algorithm Fuzzy C-Means. Algorithms for feature selection in this study used is Principal Component Analysis (PCA). PCA reduced nonsignificant attribute to created optimal dataset and can improve performance clustering and classification algorithm. Results of this research is clustering and principal feature selection give significant impact in accuracy and computation time for internet traffic classification. The combination from this three methods have successfully modeled to generate a data classification method of internet bandwidth usage.

Keywords  Classification · Clustering · Feature · Internet · K-NN
7.1 Introduction

The purpose of this research is to investigate how to improve the K-Nearest Neighbor (K-NN) classification accuracy and computation time for internet bandwidth usage classification process. K-NN algorithm calculates all distances distribution of existing data, so the results of the classification are more accurate because it considers all the possibilities that exist, the process of rigorous computational algorithms K-NN finally have a weakness in terms of performance that is the slow process of classification.

In addressing the weakness of K-NN algorithm in this research, an experiment study has been conducted by firstly forming the ready-classified datasets, which is done by clustering beforehand. Clustering process is done so that the spread of the data occurs naturally based on similarity of existing data, as the data is scattered then carried out a process of classification, clustering process is expected to accelerate the performance of K-NN algorithm. This clustering algorithm is an algorithm that meets the Fuzzy C Mean. At Algorithm Fuzzy C Mean, number of clusters to be formed does not need to be determined in advance, so the number of clusters that formed later would show the grouping of data occurs. In a recent study in 2012 conducted by LOU Xiaojun, LI Junying, and Haitao LIU still stated that the Fuzzy C Mean generally have a weakness for the output partition/cluster for the same dataset [1].

Based on these previous research there are some opportunity to develop an Internet traffic classification model using machine learning algorithms. In this research K-NN algorithm is used for that classification, Fuzzy C Mean algorithm for clustering process and Principal Feature Selection for principal feature selection. One advantage of Fuzzy C-Mean algorithm is the number of classification does not need to be specified from the beginning such as in Fuzzy K Mean algorithm. It is expected that the classification is formed to represent real data. However Fuzzy C Mean requires a feature of selection for data to be used that Internet traffic with the same correlation could fit into the same classification. Another thing that could be the development on these studies is how the process of finding the features and precise fit.

7.2 Literature Review

7.2.1 K-Nearest Neighbor

Algorithm k-nearest neighbor (k-NN or KNN) is an algorithm used for the classification of the object based on the distance between the objects. The data used for the classification process in the K-NN projected into multiple dimensions, where each dimension represents the features of the data [2]. The space is divided into sections based on the classification of data that are classified. A point in this space marked class C if class C is the most common classification of the k nearest neighbors of the dot. Near or far neighbors Euclidean are usually calculated based
on the distance learning phase, the algorithm is simply to store the vectors of features and classification of the learning data. In the classification phase, the same features are calculated for test data (which classification is not known). The distance of this new vector of all learning data vector is calculated, and the number k closest is retrieved [3]. K-NN algorithm accuracy is greatly influenced by the presence or absence of features that are not relevant, or if the weight of such features is not equivalent to its relevance to the classification. Research on these algorithms largely discusses how to choose and give weight to the feature, in order to become a better classification performance.

7.2.2 Fuzzy C-Mean

Fuzzy C-Means clustering is a technique to clustering of each data point in dataset which determined by the degree of membership. This technique was first introduced by Jim Bezdek in 1981. First step of Fuzzy C-Means is to determine cluster centers, which marked the average location for each cluster. In the initial condition, the center of the cluster is still not accurate. Each data point has a degree of membership for each cluster. By improving the cluster centers and the degree of membership of each data point repeatedly, it will be seen that the center cluster will move towards the right location. This loop is based on minimization of an objective function that describes the distance from the given data point to the center of the cluster that is weighted by the degrees of membership of data points. Output of Fuzzy C-Means is a row of cluster centers and some degree of membership for each data point. First of all, the method provides membership values, which can be useful for assessing the validity of the cluster structure obtained. Second, the method has a simple and efficient algorithm which makes it applicable in a broad class of situations [4].

7.2.3 Principal Feature Selection

Principal Component Analysis (PCA) is the principal feature selection method used in this research. Esbensen [5], explained that the main component analysis (PCA) is a multivariate data analysis method mostly used for exploratory analysis of data, outlier detection, rank (dimension) reduction, graphical clustering, classification, and regression. The proper understanding of PCA is a prerequisite for the controlling other latent variable methods, including Principal Component Analysis regression, multivariate calibration and classification. Current use of PCA is associated with the latent data structure visualization with a graphical plot. Since PCA allows interpretation based on all variables simultaneously, then PCA is mostly used as the first data analysis conducted on multivariate data sets, although further data analysis with other methods even more advanced one may be required [6].
7.3 Research Methodology

The purpose of this study is to investigate the impact of clustering and principal feature selection for K-NN Classification accuracy and computation time by using Fuzzy C-Mean as clustering algorithm and Principal Component Analysis (PCA) as principal feature selection. PCA is first technique implement in this research for analyzing internet traffic dataset and to find the discriminant feature [7]. Fuzzy C-Mean is a technique for improving the K-NN computation time, Fuzzy C-Mean is the solution to help K-NN in data clustering, Fuzzy C-Mean will make the distribution and grouping of data so as to make the K-NN does not need to perform the calculation of all distances between existing data. The research methodology to achieve these research objectives, as shown in Fig. 7.1.

The contribution in this research shown in the blue box on Fig. 7.1. This research dataset is collecting from mooreset dataset which used in another internet traffic classification research, this data is collected from http://www.cl.cam.ac.uk/research/srg/netos/nprobe/data/papers/sigmetrics/ [8].

Fig. 7.1 Research methodology
7.4 Experimental Result

This research used dataset 10 for experimental dataset, the dataset class and number of flow is present in Table 7.1. The experimental result is present in Table 7.2 until Tables 7.3 and 7.4.

Table 7.1 shows that dataset 10 has a 65036. Fuzzy C-Mean clustering the data before classified by K-NN, Fuzzy C-Mean clustering is expected to improve the computation time of the algorithm K-NN. Principal Feature Selection done by PCA via transform the dataset into new dataset, the new dataset is create by dimensional reduction from PCA. Table 7.2 shown that Fuzzy C-Mean gave significant impact for K-NN Classification in execution time, K-NN execution time decreases almost 400 s. The feature reduction which done by PCA shows the most significant impact, Table 7.2 shown execution time improvement is more less 70 %, unfortunately

<table>
<thead>
<tr>
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<tr>
<td>WWW</td>
<td>54436</td>
</tr>
<tr>
<td>Mail</td>
<td>6592</td>
</tr>
<tr>
<td>FTP-control (fc)</td>
<td>81</td>
</tr>
<tr>
<td>FTP-pasv (fp)</td>
<td>257</td>
</tr>
<tr>
<td>Attack</td>
<td>446</td>
</tr>
<tr>
<td>P2p</td>
<td>624</td>
</tr>
<tr>
<td>Database (db)</td>
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<tr>
<td>Ftp-data (fd)</td>
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</tr>
<tr>
<td>Multimedia (mm)</td>
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<tr>
<td>Services (srv)</td>
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<tr>
<td>Interactive (int)</td>
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</tr>
<tr>
<td>Games (gm)</td>
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<tr>
<td>Total</td>
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<table>
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</tr>
<tr>
<td>Traditional K-NN + Fuzzy C-Mean</td>
<td>839</td>
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<tr>
<td>Traditional K-NN + Fuzzy C-Mean + PCA</td>
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<table>
<thead>
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<th>Algorithm</th>
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<td>98.41</td>
</tr>
<tr>
<td>Traditional K-NN + Fuzzy C-Mean</td>
<td>96.70</td>
</tr>
<tr>
<td>Traditional K-NN + Fuzzy C-Mean + PCA</td>
<td>98.06</td>
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K-NN classification accuracy is decline when Fuzzy C-Mean and PCA implement in classification model as shown in Table 7.3. In Table 7.4 also shown that Max Precision value is decline when Fuzzy C-Mean and PCA implement in this classification model.

7.5 Conclusion

K-NN has great accuracy in internet traffic classification. K-NN disadvantage is its high execution time. To improve the execution of K-NN algorithms needed to carry out the reduction features PCA and Fuzzy C-Mean algorithm to form a cluster prior to the classification process, with the combination of two algorithm. K-NN algorithm would have a shorter execution time and but unfortunately the classification accuracy declining. In the future, work will be conducted on how to figure out number of class in dataset and improving accuracy from K-NN but still have short execution time.

Acknowledgments We would like to thank to Indonesian Higher Education and Research for this opportunity and research grant, and also for University Of Ciputra for research facility.

References


Table 7.4 Classification summary

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<tr>
<td>Max precision value</td>
<td>99.77 %</td>
<td>99.09 %</td>
<td>99.60 %</td>
</tr>
<tr>
<td>Min precision value</td>
<td>0 %</td>
<td>0 %</td>
<td>0 %</td>
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<tr>
<td>Number of class in dataset</td>
<td>11</td>
<td>11</td>
<td>11</td>
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<tr>
<td>Number of class figure out in classification</td>
<td>10</td>
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<td>9</td>
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