Hand-written Digits Classification and Letter Recognition

Group 10
Sixiang Ma, Yuan Xiao, Xiaokuan Zhang

12/06/2016

Abstract

say something

1 Introduction

1.1 Problem Description

Our group wants to solve the problem of classifying hand-written digits and black-and-white rectangular pixel-displayed letters. We have two datasets from UCI machine learning repository [10]. One is hand-written digits dataset [1], from a total of 43 people, 30 contributed to the training set and different 13 to the test set. Another is letter recognition dataset [2]. The character images were based on 20 different fonts. More details can be found by visiting the links.

1.2 Classifying Algorithms

In this report, we test three machine learning algorithms, i.e., Support Vector Machine (SVM), Neural Networks, and Naive Bayes. We will present the detail of algorithms in Section 3.

1.3 Result Summary

For the first dataset, after tuning the parameters, the three classifiers can achieve , , , accuracy.

2 Background

The hand-written digit dataset was first used in [9]. In the paper they combined different classifiers to obtain a better performance. The letter recognition dataset was first used in [6]. They generated classification rules to distinguish different letters.

3 Methodology

3.1 Support Vector Machine

Support vector machines (SVMs) [4] are supervised learning models that analyze data for classicification or regression. Given a set of training examples, which are marked with their belonging categories, a SVM algorithm builds a model to recognize and assign testing examples to the predicted categories.

Say something about kernel functions.

3.2 Neural Networks

Neural networks, or artificial neural networks [7], simulate the functions of nerve cells of human brain and serve as an important computational approach in machine learning. They typically form a structure of multiple layers of basic perceptrons and support both supervised and unsupervised learning.

Neural networks have a long history, dating back to the 1940s [11]. However, the idea of artificial neural networks was not popular at early days due to its limitation in solving logical calculations [12]. Modern neural networks revived in the past decade, along with the rise of deep learning [3, 13].

3.3 Naive Bayes

Naive Bayes classifier makes use of the Bayes Theorem. It is basically a conditional probability model. It is one of the simplest machine learning algorithms. Compared to Bayesian Networks, Naive Bayes is technically a special case by assuming that all features are conditionally independent from each other given the class label. One of the earliest papers that described this algorithm was from 1970s [5].

4 Evaluation

In this project, we mainly used `Weka` [8] to test different machine learning algorithms.

4.1 Hand-written Digits Classification

4.1.1 Support Vector Machine

4.1.2 Neural Networks

4.1.3 Naive Bayes

4.2 Letter Recognition

4.2.1 Support Vector Machine

4.2.2 Neural Networks

4.2.3 Naive Bayes

5 Discussion

6 Conclusion

References

[1] Optical recognition of handwritten digits data set. `http://archive.ics.uci.edu/ml/datasets/Optical+Recognition+of+Handwritten+Digits`.

[2] Optical recognition of handwritten digits data set. `https://archive.ics.uci.edu/ml/datasets/Letter+Recognition`.

[3] Yoshua Bengio. Learning deep architectures for ai. *Foundations and trends® in Machine Learning*, 2(1):1–127, 2009.

[4] Corinna Cortes and Vladimir Vapnik. Support-vector networks. *Machine learning*, 20(3):273–297, 1995.

[5] Richard O Duda, Peter E Hart, et al. *Pattern classification and scene analysis*, volume 3. Wiley New York, 1973.

[6] Peter W Frey and David J Slate. Letter recognition using holland-style adaptive classifiers. *Machine Learning*, 6:161, 1991.

[7] Martin T Hagan, Howard B Demuth, Mark H Beale, and Orlando De Jesús. *Neural network design*, volume 20. PWS publishing company Boston, 1996.

[8] Mark Hall, Eibe Frank, Geoffrey Holmes, Bernhard Pfahringer, Peter Reutemann, and Ian H Witten. The weka data mining software: an update. *ACM SIGKDD explorations newsletter*, 11(1):10–18, 2009.

[9] C Kaynak. Methods of combining multiple classifiers and their applications to handwritten digit recognition. Master's thesis, Institute of Graduate Studies in Science and Engineering, Bogazici University, 1995.

[10] M. Lichman. UCI machine learning repository, 2013.

[11] Warren S McCulloch and Walter Pitts. A logical calculus of the ideas immanent in nervous activity. *The bulletin of mathematical biophysics*, 5(4):115–133, 1943.

[12] Marvin Minsky and Seymour Papert. Perceptrons: An introduction to computational geometry (expanded edn), 1988.

[13] Jürgen Schmidhuber. Deep learning in neural networks: An overview. *Neural Networks*, 61:85–117, 2015.