TEMPORAL - SPATIAL RECOGNIZER FOR MULTI-LABEL DATA

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Abstrak

Pengecaman corak merupakan satu tugas perlombongan data yang penting dengan aplikasi praktikal dalam pelbagai bidang seperti perubatan dan pengagihan spesis. Aplikasi tersebut melibatkan pertindihan data yang terkandung di dalam set data berbilang label. Oleh itu, terdapat keperluan bagi algoritma pengecaman yang boleh memisahkan pertindihan data untuk mengenal pasti corak yang betul. Kaedah pengecaman corak sedia ada adalah sensitif terhadap gangguan dan data yang bertindih kerana ia tidak dapat mengenali corak apabila terdapat perubahan pada lokasi data. Kaedah tersebut juga tidak melibatkan maklumat temporal dalam proses pengecaman dan ini membawa kepada kualiti kelompok data yang rendah. Dalam kajian ini, satu kaedah penambahbaikan pengecaman corak berdasarkan Daya Ingatan Temporal Hierarki (HTM) dicadangkan. Algoritma imHTM (HTM yang ditambahbaik) mengandungi penambahbaikan dalam dua komponennya; pengekstrakan fitur dan pengelompokan data. Penambahbaikan yang pertama dikenali sebagai algoritma $_{T}$S-Layer Neocognitron yang menyelesaikan masalah perubahan lokasi data dalam fasa pengekstrakan fitur. Dalam pada itu, komponen kedua iaitu pengugusan data mempunyai 2 dua penambahbaikan, $_{T}$FCM dan cFCM ($_{T}$FCM dengan metrik had-Chebyshev), membolehkan pertindihan data yang terdapat dalam corak dipisahkan dengan tepat ke dalam kelompok data yang berkaitan dengan menggunakan penglompokan temporal. Eksperimen ke atas lima set data telah dijalankan bagi membandingkan prestasi algoritma yang dicadangkan (imHTM) dengan kaedah pengecaman corak berasaskan statistik, templat dan struktur. Keputusan menunjukkan peratusan pengecaman yang berjaya adalah sebanyak 99% berbanding dengan kaedah pengecaman yang lain. Ini menunjukkan bahawa HTM yang ditambahbaik dapat membuat pengecaman corak yang optimum terutamanya bagi corak yang terdapat di dalam set data berbilang label.

Kata kunci: Model Temporal hierarki Daya Ingatan, Neocognitrion, Pengecaman Corak, Data berbilang label, Perlombongan Data

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Abstract

Pattern recognition is an important artificial intelligence task with practical applications in many fields such as medical and species distribution. Such application involves overlapping data points which are demonstrated in the multi- label dataset. Hence, there is a need for a recognition algorithm that can separate the overlapping data points in order to recognize the correct pattern. Existing recognition methods suffer from sensitivity to noise and overlapping points as they could not recognize a pattern when there is a shift in the position of the data points. Furthermore, the methods do not implicate temporal information in the process of recognition, which leads to low quality of data clustering. In this study, an improved pattern recognition method based on Hierarchical Temporal Memory (HTM) is proposed to solve the overlapping in data points of multi- label dataset. The imHTM (Improved HTM) method includes improvement in two of its components; feature extraction and data clustering. The first improvement is realized as ${}_{T}$S-Layer Neocognitron algorithm which solves the shift in position problem in feature extraction phase. On the other hand, the data clustering step, has two improvements, ${}_{T}$FCM and cFCM (${}_{T}$FCM with limit-Chebyshev distance metric) that allows the overlapped data points which occur in patterns to be separated correctly into the relevant clusters by temporal clustering. Experiments on five datasets were conducted to compare the proposed method (imHTM) against statistical, template and structural pattern recognition methods. The results showed that the percentage of success in recognition accuracy is 99% as compared with the template matching method (Featured-Based Approach, Area-Based Approach), statistical method (Principal Component Analysis, Linear Discriminant Analysis, Support Vector Machines and Neural Network) and structural method (original HTM). The findings indicate that the improved HTM can give an optimum pattern recognition accuracy, especially the ones in multi- label dataset.

Keywords: Hierarchical Temporal Memory Model, Neocognitron, Pattern Recognition, Multi- label data, Data mining.

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Glossary of Terms

HTM	Hierarchical Temporal Memory
FCM	Fuzzy c-means clustering
PR	Pattern Recognition
RNN	Recurrent Neural Network
MPF	Memory Prediction Theory
MLT	Medical Laboratory Technician
MLD	Multi- label data
MLL	Multi- label learning
NCBI	National Center for Biotechnology and Information
ASR	Automatic speech recognition
ASIFT	Affine scale invariant feature transform
MRI	Magnetic resonance imaging
OSAD	Optimized Sum of Absolute Difference
SSD	Sum of Square Difference
NCC	Normalized Cross Correlation
SSTN	Sum Square T-distribution Normalized
SAD	Sum of Absolute Difference
PTM	Polyhedral template matching
PCA	Principal Component Analysis
DMSC	Dscriminative multi-scale sparse coding
SVM	Support Vector Machines
LDA	Linear Discriminant Analysis
NN	Group Method of Data Handling
PNN	Probabilistic Neural Networks

PFCM	Possiblistic fuzzy c-means
CLA	Cortical Learning Algorithm
$_T$S-layer	Time S-layer Neocognitron algorithm
$_T$FCM	Temporal Fuzzy C-Means
imHTM	Improved Hierarchical Temporal Memory
HMM	Hidden Markov Model
$_c$FCM	Chebyshev Fuzzy C-Means

CHAPTER ONE
INTRODUCTION

1.1 Background

Pattern recognition (PR) is an operation of detecting patterns in data sets and using this data to characterize new data (Sao, Hegadi, & Karmakar, et al.,2014). It is defined as a classification of input data via extraction important features from a lot of noisy data (Paul, Magdon-Ismail, & Drineas, et al.,2016). The identification or interpretation of the pattern in an image can be described effectively with the help of Pattern Recognition (PR) (Kaur & Kaur, et al.,2013). PR is a form of machine learning, which is a field in artificial intelligence (Wu & Toet, et al.,2014). Machine learning in turn is divided into two main groups: supervised and unsupervised learning (Shwartz & Ben-David, et al.,2014). In supervised learning, the computer system is trained by using a classis that are previously defined, and then using this classes to classify unknown objects depending on the patterns that were detected in training (Bova et al., 2016). In an unsupervised learning, the classes are not defined beforehand, and the computer system clusters the data using a group of general rules (Serb, Bill, Ali Khiat, Legenstein, & Prodromakis, et al.,2016). Unsupervised is equivalent to classification known as clustering, which groups the input patterns into clusters depending on the measures of similarity (the distance between input patterns). Other approaches to PR involve semi-supervised learning, which try to find new similarity relationships using previously defined classes to determine new groups (Shwartz & Ben-David, et al.,2014). On the other hand, reinforcement learning is an approach that improve the decisions iteratively, depending on the feedback technique and assigning a reward criterion (Duan, Chen, Houthooft, Schulman, & Abbeel, et al.,2016).

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