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Intelligent Machine learning Algorithms for processing the Brain Images

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Publications

1. Heba Mohsen, El-Sayed A. El-Dahshan, El-Sayed M. El-Horbaty and Abdel-Badeeh M. Salem. Classification using Deep Learning Neural Networks for Brain Tumors, Future Computing and Informatics Journal, 2018, doi: 10.1016/j.fcij.2017.12.001 (accepted).

2. Heba Mohsen, El-Sayed A. El-Dahshan, El-Sayed M. El-Horbaty and Abdel-Badeeh M. Salem. Classification of Brain MRI for Alzheimer's Disease Based on Linear Discriminate Analysis, Egyptian Computer Science Journal, September 2017, Vol. 41 No.3, pp. 44-52.

3. Heba Mohsen, El-Sayed A. El-Dahshan, El-Sayed M. El-Horbaty and Abdel-Badeeh M. Salem. Brain Tumor Type Classification Based on Support Vector Machine in Magnetic Resonance Images, Annals Of “Dunarea De Jos” University Of Galati, Mathematics, Physics, Theoretical Mechanics, Fascicle II, Year IX (XL) 2017, No. 1.

4. Heba Mohsen, El-Sayed A. El-Dahshan, El-Sayed M. El-Horbaty and Abdel-Badeeh M. Salem. Intelligent Methodology for Brain Tumors Classification in Magnetic Resonance Images, International Journal of Computers, 2017, Vol 11, pp.1-5.

5. Heba Mohsen, El-Sayed A. El-Dahshan, El-Sayed M. El-Horbaty and Abdel-Badeeh M. Salem. A Comparative Study of Segmentation Techniques for Brain Magnetic Resonance Images, Athens: ATINER'S Conference Paper Series, No: COM2016-1994, 2016.

Abstract

Machine learning became very important in extracting meaningful relationships and making accurate prediction in many fields. In the area of processing the brain images, Computer Aided-Diagnosis (CAD) systems are basically relied on different machine learning techniques in all its stages to implement a system that can help the radiologists by providing a second opinion that can assist in detection and diagnosis of brain tumors based on imaging techniques that are widely used in clinical care. Magnetic resonance imaging (MRI) is an imaging technique that plays a vital role in detection and diagnosis of brain tumors in both research and clinical care for providing a detailed information about the brain structure and its soft tissues.

This study concerned with developing a CAD system that can process the brain MR images for detection and diagnosis of different brain tumors using several machine learning techniques. In this study, two types of systems are implemented. The first type is to differential diagnose of 3 types of malignant brain tumors (i.e., glioblastoma, sarcoma and metastatic bronchogenic carcinoma) from normal brain subjects using brain MRIs from a real online dataset of brain MRIs. However, the second type is to differential diagnose of cognitive normal (CN) brain from Alzheimer's disease (AD) brain subjects using brain MRIs from two real online datasets of brain MRIs.

For the first type of CAD system, three CAD systems with several models are presented in this study through the chapters. The three CAD systems included three stages: segmentation, feature extraction and selection and classification. K-means and Fuzzy C-means are two segmentation techniques that have been used separately to segment the input brain MRIs from the dataset used. Gray level co-occurrence matrix (GLCM) and Discrete Wavelet Transform (DWT) integrated with Principal Component Analysis (PCA) are also two techniques for feature extraction and selection that have been used separately. The three CAD system models are combination of these techniques in the first two stages with a selected

classifier for the final stage. In the last stage, for the classification three different supervised classifiers are used for each system: (i) hybrid Support Vector Machine (SVM) which is integration of Linear-SVM for differentiating between normal and abnormal brain subjects and Multi-SVM classifier for identifying the tumor type in the abnormal brain subjects, (ii) SMO-SVM which is sequential minimal optimization (SMO) algorithm for training Support Vector Machine (SVM) and (iii) Deep Neural Network (DNN). The performance of the three classifier is evaluated using different measures giving high average classification rates and precision that proved their efficiency and reliability.

The second type of CAD systems presented in this study is a CAD system for differential diagnose of CN brain from AD brain subjects based on Linear Discriminate Analysis (LDA) classifier. The developed system includes two stages: feature extraction and selection and classification stage. Extracting the features from the input brain MRIs of the two datasets used is done for each dataset separately using DWT integrated with PCA for reducing the number of features to avoid classification complications and reduce the computation time and costs. The system presented is tested using two different datasets obtained from online datasets of real human brain MRIs. The performance of the presented system proved its efficiency and reliability in the problem which it is used for according to different performance measures.

Table of Contents

List of Figures

List of Tables

List of Abbreviations

WHO	World Health Organization
NCIS	National Cancer Institute statistics
CBTRUS	Central Brain Tumor Registry of the United States
MRI	Magnetic Resonance Imaging
CAD	Computer-Aided Detection
GLCM	Gray Level Co-Occurrence Matrix
DWT	Discrete Wavelet Transform
PCNN	Pulse-Coupled Neural Network
PCA	Principle Component Analysis
SVM	Support Vector Machine
KNN	K-Nearest Neighbor
LDA	Linear Discriminant Analysis
DNN	Deep Neural Network
CN	Cognitive Normal Brain
AD	Alzheimer's Disease
CT	Computed Tomography
PET	Positron Emission Tomography
SPECT	Single Photon Emission Computed Tomography
FPCNN	Feedback Pulse-Coupled Neural Network
PEG	Pneumoencephalography
fMRI	Functional Magnetic Resonance Imaging
EEG	Electroencephalography
MEG	Magnetoencephalography
CNN	Convolutional Neural Networks
ANN	Artificial Neural Network
MRF	Markov Random Fields
SOM	Self-Organizing Maps
FCM	Fuzzy C-means

DL	Deep Learning
NN	Neural Networks
RBF	Radial Basis Function
FFNN	Feed Forward Neural Network
MLP	Multi-Layer Perceptron
BP	Backpropagation algorithm
GM	Gray Matter
WM	White Matter
CSF	Cerebrospinal Fluid
Linear-SVM	Linear Support Vector Machine
multi-SVM	Multi-class Support Vector Machine
WEKA	Waikato Environment for Knowledge Analysis
SMO-SVM	Sequential Minimal Optimization algorithm for SVM
CSV	Comma Separated Values
ROC	Receiver Operating Characteristic
AUC	Area Under the Curve
MCI	Mild Cognitive Impairment
ADNI	Alzheimer's Disease Neuroimaging Initiative