MRI-Based Classifiers for the Detection of Chiari Malformation

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Importance for Chiari patients

An objective diagnosis for Chiari malformation (CM) is not yet possible. Although MRI imaging has greatly improved diagnostic procedures, the interpretation of the images is largely subjective. In this project we aim to create a computer learning based algorithm to objectively identify features within MRI geometry images that are indicative of CM. This type of algorithm could help provide a Chiari severity index score that could be used alongside the existing Chiari diagnostic workflows.

Abstract

MRI is an indispensable diagnostic technique for detection of CM. However, there is a need to develop image analysis tools that can help doctors diagnose CM in a more objective way and that can potentially lead to more reliable and reproducible CM diagnostic procedures. In this project, we propose the use of machine learning techniques, such as support vector machines (SVM), as a tool to identify which MRI features are fundamental for the detection of CM. In particular, SVM are supervised learning models with associated learning algorithms that analyze data and recognize patterns. The aim of this project is to identify MRI features that distinguish CM patients from healthy ones by means of SVM.

Introduction

Modern medical images can be viewed as an array of pixels recorded within a computer. This array is easily converted into a matrix, where each entry is a number representing a pixel's intensity (Figure 1). Since image sizes tend to have a large amount of pixels, the resulting matrix resides in a large dimensional space. Human interpretation of this space requires relatively simple analysis of the 3D data (e.g. 1D measurement of tonsillar herniation in CM). Thus, much of the information within the full medical image sets is not taken into account; some of this information could be useful for more accurate detection of CM.

In order to make the information in each image more manageable, it is possible to seek features characteristic to CM that can be identified by a computer. One such means of utilizing computers is through a type of machine learning called support vector machines (SVM). The basic idea of SVM is that it is a "machine" that is trained with a set of examples called "input-output pairs" (Figure 2).

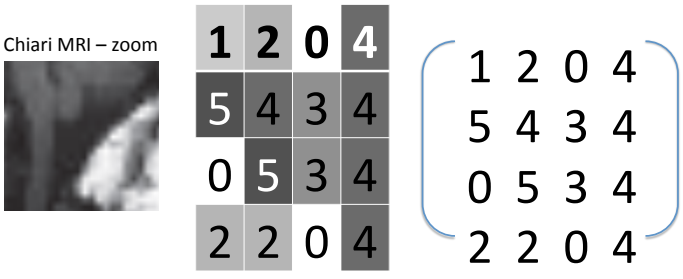

Figure 1. This simple 4x4 pixel array can easily be converted into a 4x4 matrix, where each entry is related to the pixels color.

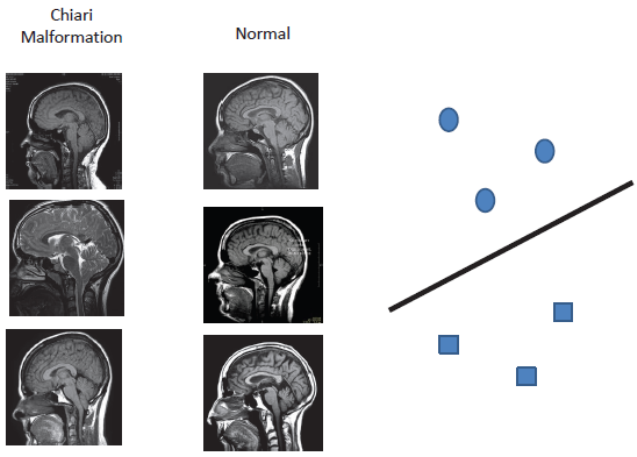

Figure 2. Here information from MRI images are represented in the second dimension, where a line dividing illness and health can be designated and used for a SVM routine.

Methods

- Feature extraction: Using MATLAB's image processing toolbox, characteristic features will be used to project the MRI image into a lower dimensional plane.
- Choice of classifier: Depending on which features are to be extracted, it will be decided whether a linear or non-linear classifier is needed.
- Training process: Here, the computer is taught via an algorithm which features are indicators of CM.
- Feature selection: By varying which features are used in the training process, which of the features is most relevant to diagnosing CM will be seen.
- Classification: Now, based on the selected features, new data will be given to the computer and its performance will be analyzed.

Expected Results

If successful, this project could lead to an objective method to help in CM diagnosis. The information revealed by SVM could also help identify new MRI features that are important to help understand CM severity.

References

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