Myocardial Fibrosis detection using Kernel Methods: preliminary results from a Cardiac Magnetic Resonance study

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Background

Asserting the presence of **Myocardial Fibrosis** using **Late Gadolinium Enhancement** (LGE) technique from Cardiac Magnetic Resonance (CMR) images is sometimes a **complex task**, even for experienced cardiac imagers. The application of **Artificial Intelligence** models to the evaluation process can be of help for **enhancing diagnostic accuracy**.

Purpose

In this work, we test different Machine Learning (ML) algorithms, namely **Kernel Methods** with **Support Vector Machine** (SVM) and **Convolutional Neural Network** (CNN) to a cohort of consecutive CMR studies. The goal is a **binary classification** task aimed to identify LGE/Myocardial Fibrosis present/absent.

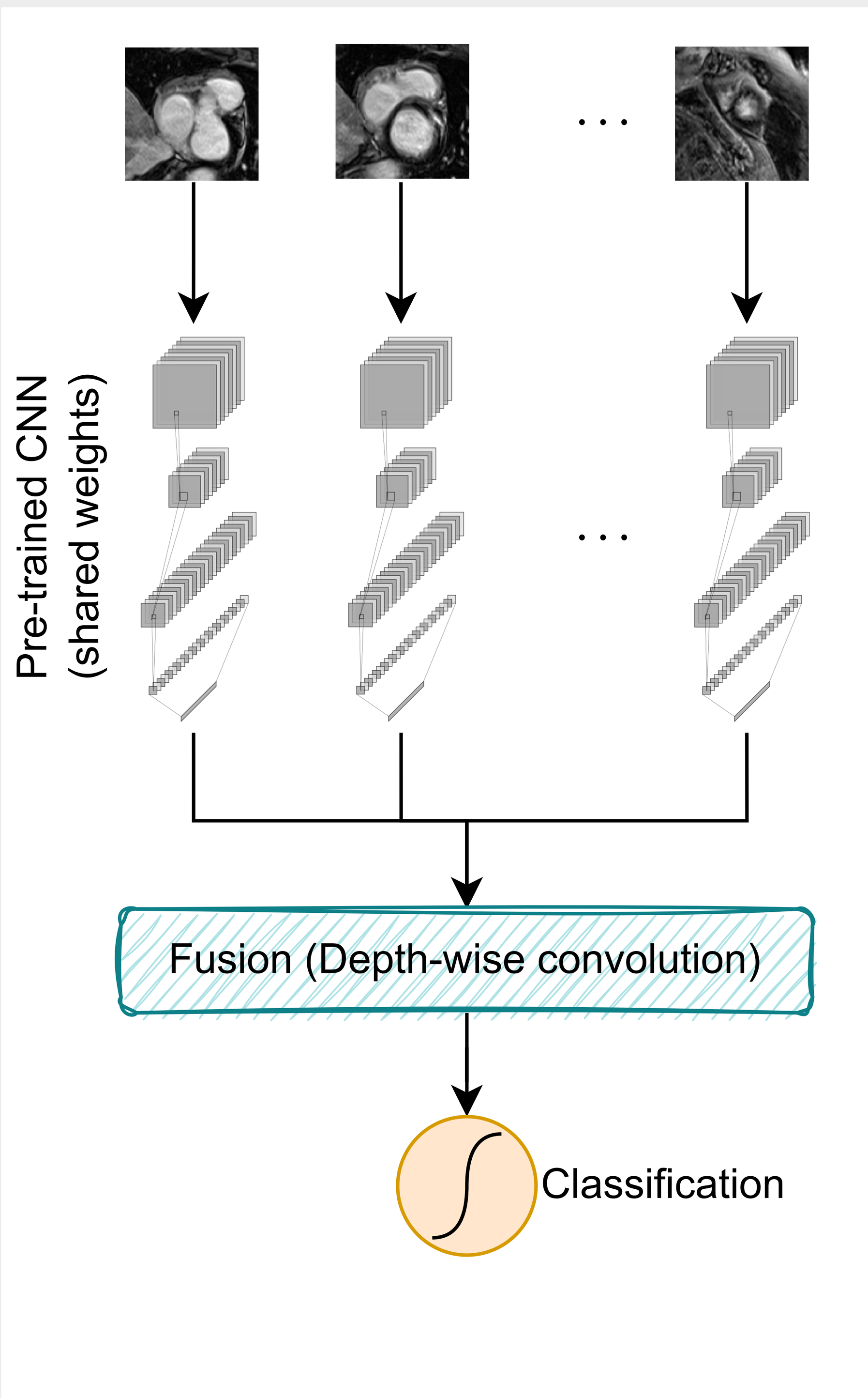
Methods and Results

Dataset consists of **642 CMR scans** plus **annotations** made by **expert cardiologists** in the form of an Excel file, where the presence of Myocardial Fibrosis is indicated alongside its location in the bullseye diagram of the heart. Subjects are **equally divided into LGE/Myocardial Fibrosis YES/NO**, according to the presence/absence of scars.

Preprocessing

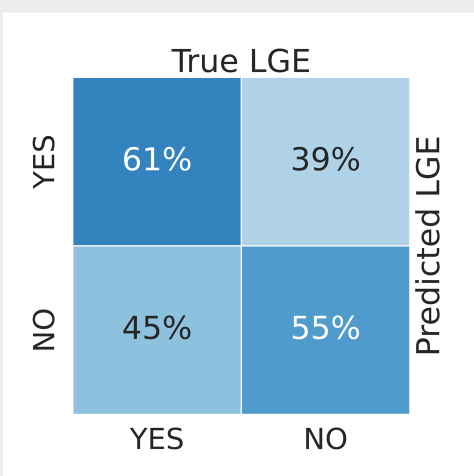
Raw DICOM files are **preprocessed** through an automated pipeline, in order to retrieve only **short-axis post contrast acquisitions**. **Heart regions** are individuated using a YOLO network, in order to focus only on data of interest. Finally, for each subject **10 slices** are extracted through interpolation, and all images resized to **128 by 128 pixels**. Dataset is divided into **training** and **test** sets, with proportions **80%-20%**.

2.5D CNN

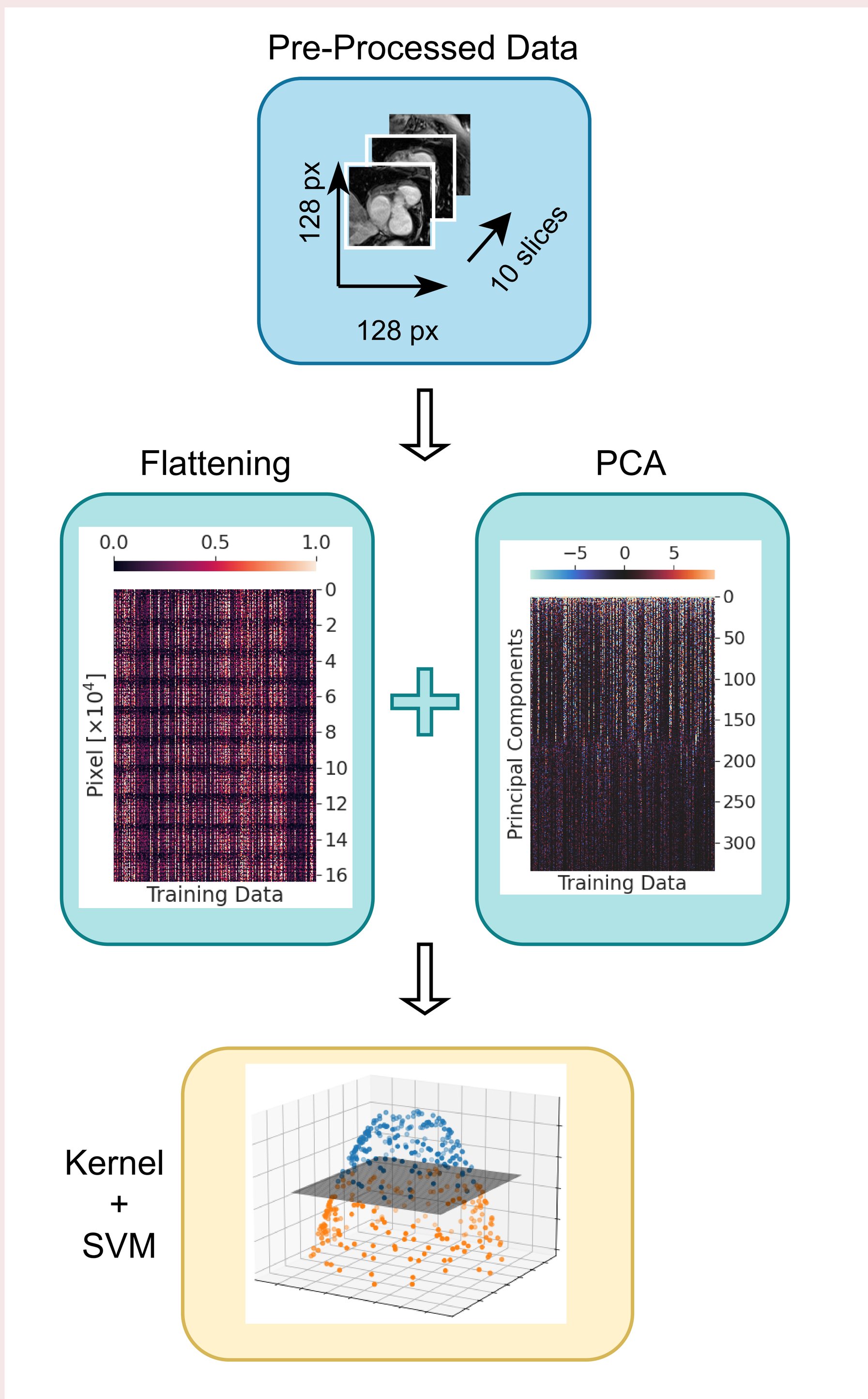


The first analysis is based on **CNN** models, **pre-trained** on the ImageNet dataset. The training is done with **shared weights** and optimized monitoring the learning rate, and implementing **early stopping** and standard **data augmentation** techniques.

Best model is found using **MobileNetV2** as backbone. Results show an **Accuracy** of 58% and a **Sensitivity** of 58%.

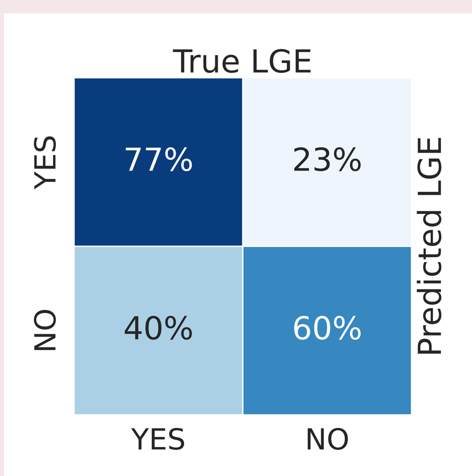


PCA + SVM

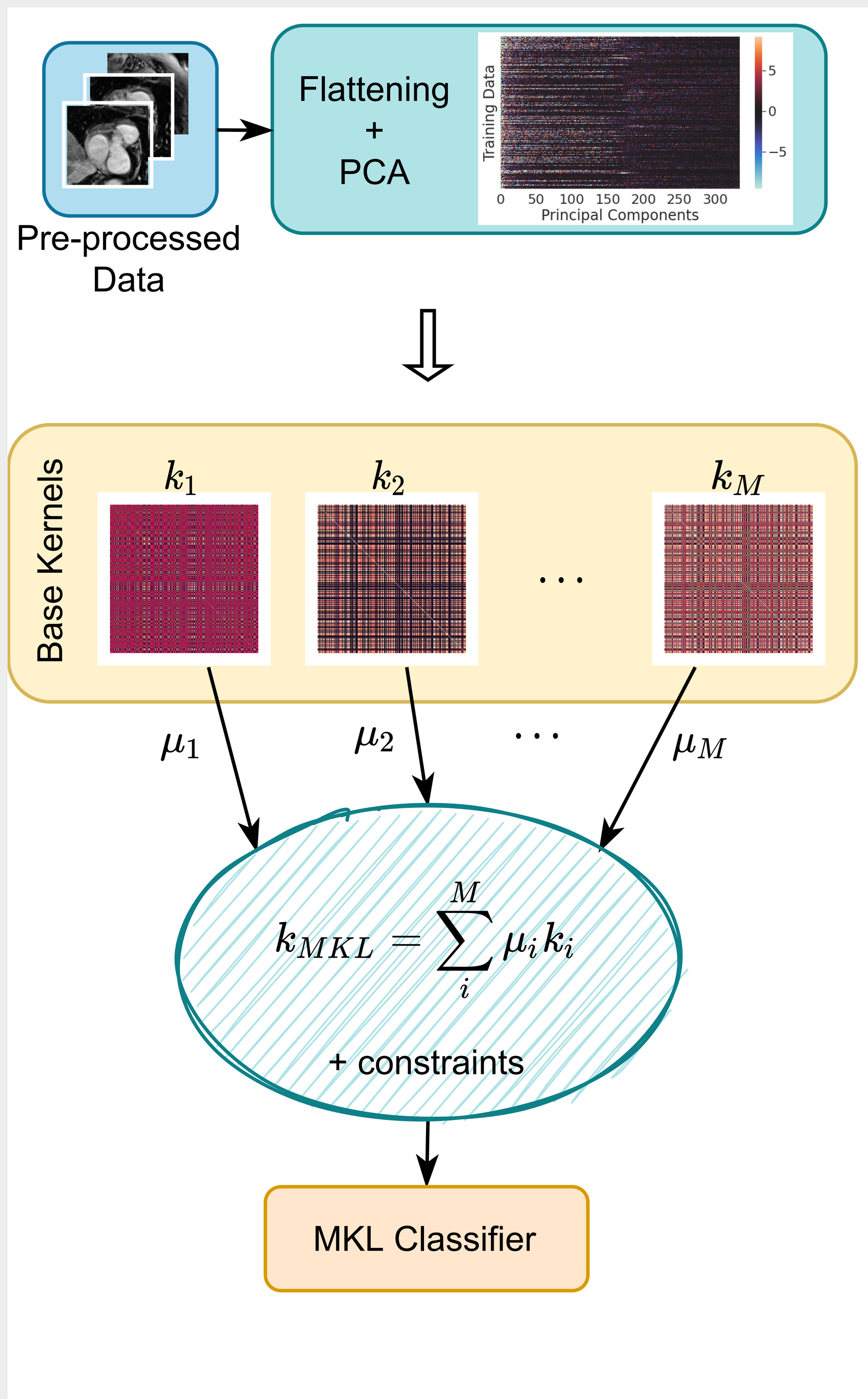


The second attempt is based on **Kernel Methods** and **SVM**. Dimensionality reduction is implemented using a **Principal Component Analysis** (PCA) retaining 99% of the variance and the resulting 335 features are passed as input to a **SVM**.**Different Kernels** (e.g. Linear, Gaussian, Cossim) are tested and models are trained and optimized using **Grid Search** with **Cross-Validation**.

The best model is obtained with a **Gaussian Kernel**, and it displays **68%** of **Accuracy** and **60%** of **Sensitivity**.

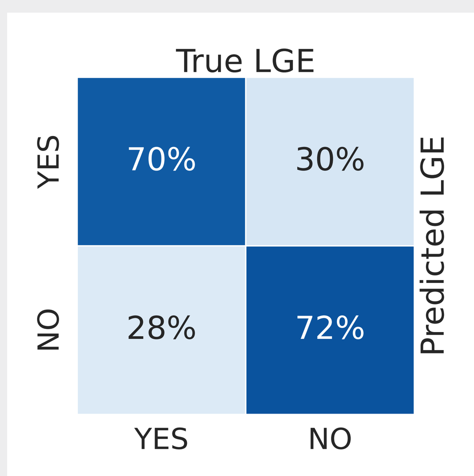


PCA + MKL



Improved results could be obtained using state-of-the-art **Multiple Kernel Learning** (MKL) algorithms. First, the dimensionality is reduced through **PCA** and then MKL is applied. With this approach, the final Kernel is given by an **optimal combination of base Kernels**. Training is performed using **Cross-Validation**.

Top results are obtaining through a combination of **multiple Gaussian Kernels**; they feature **71% Accuracy** and **72% of Sensitivity**.



Declaration of Interest The authors declare not to have any past or present conflict of interest that concerns the work hereby presented.