

# Inferring prognostic and diagnostic biomarkers from lumbar X-ray images by using machine learning methods

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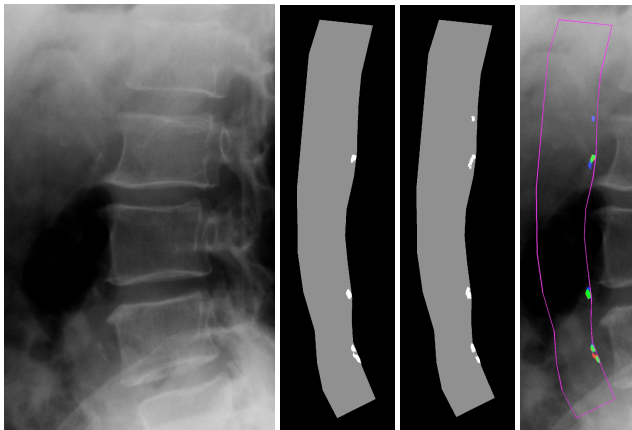
## Introduction

The CVD research project develops **new prognostic and diagnostic biomarkers** that can better assess a patient's CVD risk. The overall approach can be divided into two steps:

- An **automatic segmentation** of calcified plaques in lumbar X-ray images by applying machine learning techniques to allow a cheaper, faster, more systematic and – hopefully – more accurate risk assessment.
- The design of an expressive **biomarker** by quantifying the morphology, density and distribution of the segmented plaques (see **MACD**).

## Materials and Methods

We are working on 9000 lumbar X-ray images (baseline and follow-up) from about 4500 patients; the image resolution is 4500× 9000 pixels.



**Figure 1:** From left to right: (1) Original image (2) Segmentation from a radiologist (3) Automatic segmentation (4) Area overlap (green = true positives, blue = false positives, red = false negatives).

So far our segmentation method is based on a **supervised classifier** and contains the following steps:

- **Pre-processing:** Normalization, noise reduction, feature standardization and an aorta coordinate system.
- **Features:** Sequential floating forward selection (SFFS)
- **Classification:**  $k$  nearest neighbors ( $k$ NN) algorithm with leave-one-out cross-validation (LOO-CV).
- **Post-processing:** Morphological filtering
- **Error metric:** Area Overlap

## Results

Figure 1 illustrates the results for 16 follow-up images; we have obtained the following area overlaps:

- between our system and a radiologist:  $0.4 \pm 0.1$
- between two radiologists:  $\approx 0.55$
- for the same radiologist at two time instances:  $\approx 0.6$

## Conclusions and future work

We have presented a promising approach for automatically segmenting calcified plaques on lumbar X-ray images. Future work will focus on refining all listed steps of our method.

## Key publications

- M. De Bruijne, *A pattern classification approach to aorta calcium scoring in radiographs*, MICCAI, pages 170–171, 2005
- L. A. Conrad-Hansen, M. de Bruijne, F. Lauze, L. B. Tankó, P. Pettersen, Q. He, J. Chen, C. Christiansen, and M. Nielsen, *Quantifying Calcification in the Lumbar Aorta on X-Ray Images*. MICCAI (2), pages 352–359, 2007