One step clustering based on a-contrario framework for detection of alterations in historical violins

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Introduction

- Preventive conservation: constant monitoring of artworks to reduce the risk of damage
- Historical wood musical instruments are more susceptible to damage because of constant use
- UV induced fluorescence imaging is a widely adopted non-invasive diagnostic technique. We work with a multi-temporal series of UVIFL images.
- Surface wear detection is a semantic segmentation problem: the intact areas and the wear region(s).
- We propose a new method based on the a-contrario framework
- The main contribution: to encompass in a single model both criteria of a wear: a **high density** of pixels having **different radiometry** with respect to the reference image.

Problem Definition

- Starting from a time series of images
- Each frame is compared to the reference image providing the colour difference map
- Objective: the segmentation of each difference map with respect to semantic classes, one of which representing the wear area(s).
- Ranking the segmented clusters based on their meaningfulness

Proposed approach

- Our approach is based on the computation of the number of false alarms by rejecting a naive assumption. [Desolneux et al. 2003]
- **Naive model:** The set of points $\boldsymbol{S}$ is a random set of $|\boldsymbol{S}|$ independent uniformly distributed variables over the 3D (2D+Greylevel) space of the image.
- **The significance concept**: A cluster is more significant if it is very dense (i.e., its points are `surprisingly' close) not only spatially but also in terms of grey-level difference.
- **Proposed distance formula:** it includes both the 2D spatial distance and the transformed grey-level values:

$$D^2(i,j) = D_{sp}^2(i,j) + c \times (f(y_i)^2 + f(y_j)^2)$$

Proposed approach

- **The NFA computation:**

$$NFA(M,k,V_1,V_2\ ) = N_{test}\sum_{i=k}^{\mathrm{M}}\binom{M}{i}V_1^i[1-V_2]^{M-i}$$

K is the number of points in the cluster and M is the total number of points

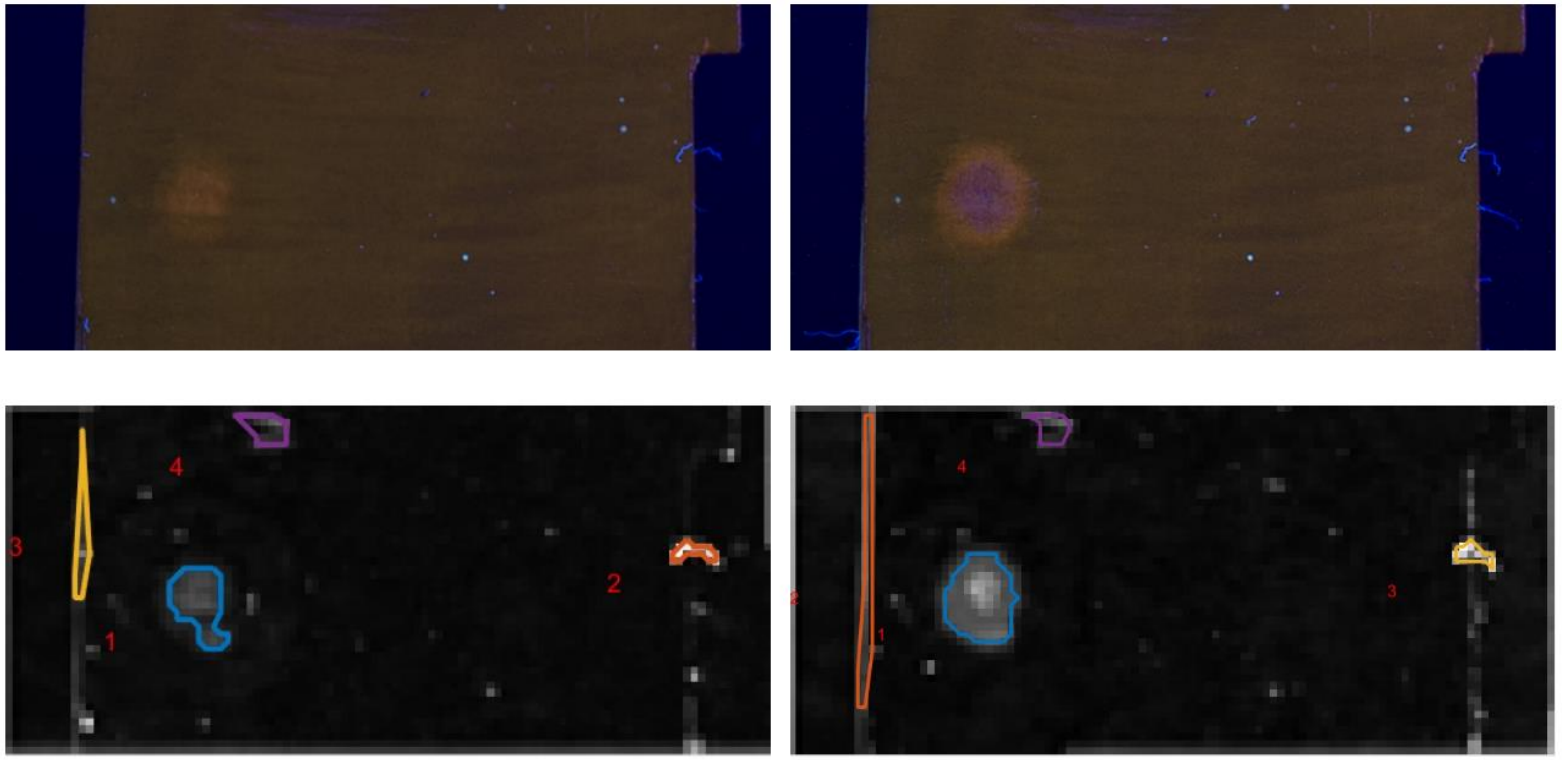
V_1 is the lower bound and for V_2 is the upper bound for the volume of the cluster

- **Meaningfulness:** For each cluster

  Ω =−log(NFA)

- Distinct clusters with the highest number of points and highest meaningfulness are the output of the algorithm.

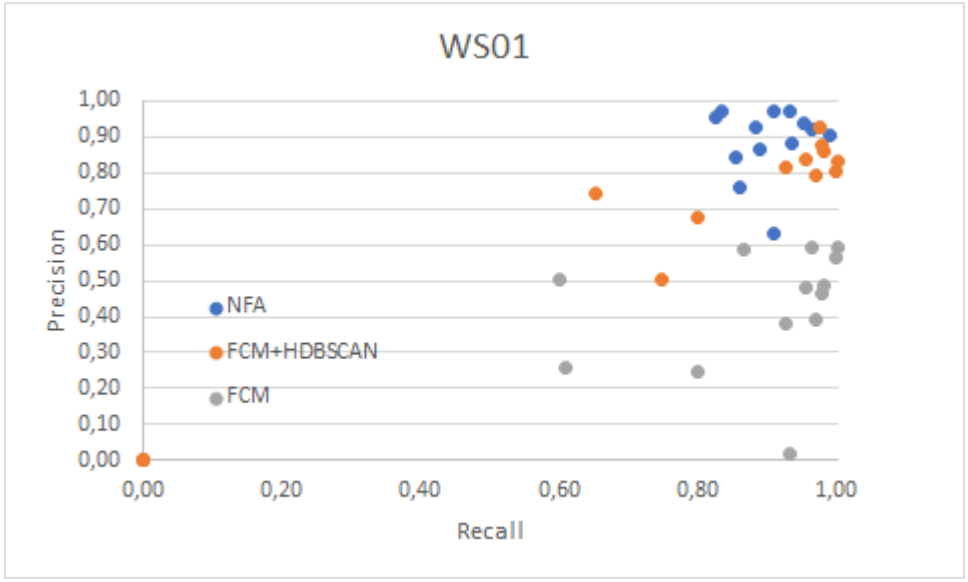
Evaluation - Results

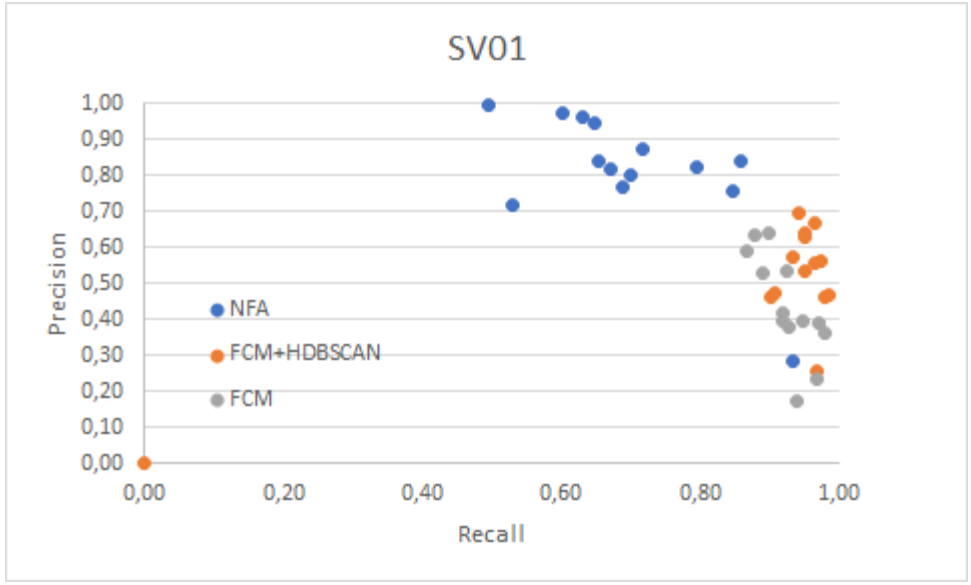


Two sample frames of UVIFL images and the result of the proposed algorithm for them. Blue colour shows the most significant cluster.

Evaluation - Results

- Comparisons with two existing algorithms:
  - FRFCM proposed by Lei et al. 2018
  - HDBSCAN proposed by Campello et al. 2015





Thanks