CNN-Based Fresco Reconstruction

January 4, 2022

Problem statement: This internship is part of a funded research project focusing on the problem of recovering the optimal spatial organization of a seriously damaged support from its original elements (see Figure 1). Main applications include the reconstruction of artworks in *cultural heritage restoration* and *archaeology*. This is highly motivated by the restoration of damaged paintings during earthquakes as well as the discovery of mosaics or frescoes from excavations (e.g. in Pompeii). This problem is difficult because of *local aspects* (elements must locally match with each other) and *global aspects* (the reassembled elements must depict a picture making sense). More precisely, the challenges addressed are the following ones: (i) very large number of fragments (typically many thousands), (ii) highly variable characteristics of fragments, (iii) irregular and eroded fragments, (iv) presence of spurious fragments, (v) missing fragments and (vi) partial of complete degradation of the fresco model. Recent attempts to solve this problem include features-based matching [1] or machine learning-based approaches [2]. Nevertheless, when (vi) holds, these approaches either fail to be robust (because of handcrafted features) or are limited to the reconstruction of of frescoes of very small size.

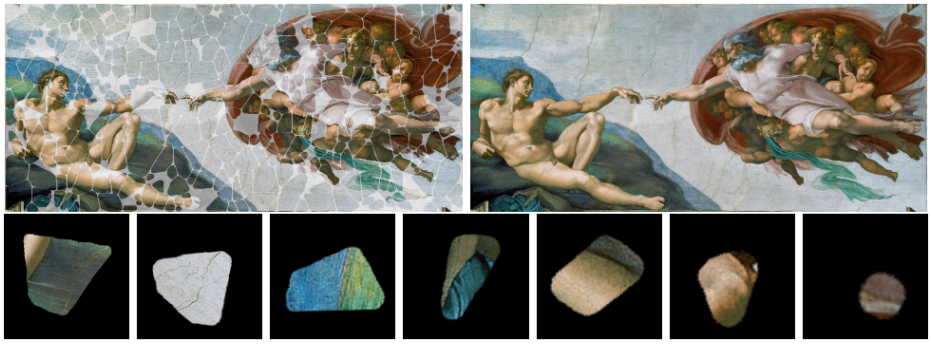

Figure 1: Example of an ideal fresco reconstruction (top left) from both fresco model (top right) and a collection of fragment images (bottom). Only a subset of the latter are represented.

Objectives: Firstly, the student will consider the possibility to use *convolutional neural networks* to solve *regression* problems where we aim at rating either the positioning of a fragment with respect to the fresco model or the relative positioning of a couple of fragments. For doing so, specific datasets will be derived from an existing one and between-class/within-class imbalance will be carefully addressed. Secondly, the resulting networks will be optimized and evaluated against reference approaches.

Prerequisites: A highly motivated candidate is expected at master level (or equivalent) with a good mathematical and image processing background as well as good programming skills and technical english level. Knowledge in optimization is preferred but not mandatory.

Duration/salary: From 4 to 6 months / About 530 euros per month.

Ph.D. continuation: Possible.

Location: The internship will take place in the SATIE lab at Gif-sur-yvette (30 minutes from Paris).

Contact: Please feel free to send an e-mail to `nicolas.lerme@universite-paris-saclay.fr`.

References

[1] N. Lermé, S. Le Hégarat-Mascle, B. Zhang, and E. Aldea. Fast and efficient reconstruction of digitized frescoes. *Pattern Recognition Letters (PRL)*, 138:417–423, 2020.

[2] M.-M. Paumard, D. Picard, and H. Tabia. Deepzzle: Solving visual jigsaw puzzles with deep learning and shortest path optimization. *IEEE Transactions on Image Processing*, 29:3569–3581, 2020.