

Master Internship Position

Spatial relations reasoning for interpreting byzantine seals

November 29, 2021

1 Information about the internship

- **Supervisors:** Isabelle BLOCH and Victoria EYHARABIDE.
- **Location:** LIP6 UMR7606 - Laboratoire de recherche en informatique, Sorbonne Université.
- **Duration:** 6 months (starting preferably from February or March 2022)
- **Keywords:** Deep Learning. Computational intelligence. Fuzzy Logic. Machine Learning. Knowledge and model of reasoning. Byzantine sigillography.

2 Context

The analysis and interpretation of Byzantine seals is a complex task that requires expert knowledge of Byzantine sigillography and numismatics. Currently, there are no tools for guiding or assisting these experts in their analysis. We shall rely on the expertise of I. Bloch from LIP6 at Sorbonne Université and former member of the LTCI team at Télécom Paris, an expert in the field of mathematical modeling of spatial relations and spatial reasoning [1]. We plan to adapt the methods proposed by I. Bloch et al. to the field of cultural heritage. The majority of seals have two sides, one which in principle carries text and the other which can carry text or an image with decorations around it, such as a border of dots. The spatial organization of these objects and their arrangement in relation to each other could guide identification algorithms. By modeling the intrinsic spatial relations within seals, we should be able to contribute to their interpretation, especially during the stages of computer segmentation and recognition.

3 Goals

During the internship, the following tasks will be addressed:

1. The first task will be to contribute to the creation of a knowledge graph [3] by identifying the spatial relations (i) involved in the transcriptions and descriptions of already existing published seals, and (ii) provided by our experts in the field, to represent the objects and relations present in seals. Not only the figures and scenes will be studied, but also the object relations within a seal (such as the Virgin Mary holding the Child, a patriarchal cross mounted on three steps). We are particularly interested in modeling the spatial relations relevant to characterize objects or characters in the seals.
2. The next task will be the mathematical modeling of these relations (building on existing fuzzy models, for instance based on morphological dilations, adapting them to this specific field of application, and proposing new ones for relations not modeled before).
3. The use of fuzzy logic to reason from expressions as imprecise as “in the center”, “next to”, or “between” has given excellent results in medical imaging. Once the objects and their relations have been modeled, we can analyze, interpret, or even validate or refute existing knowledge with mathematical evidence. For instance, this type of reasoning could improve segmentation and recognition results provided by a neural network.

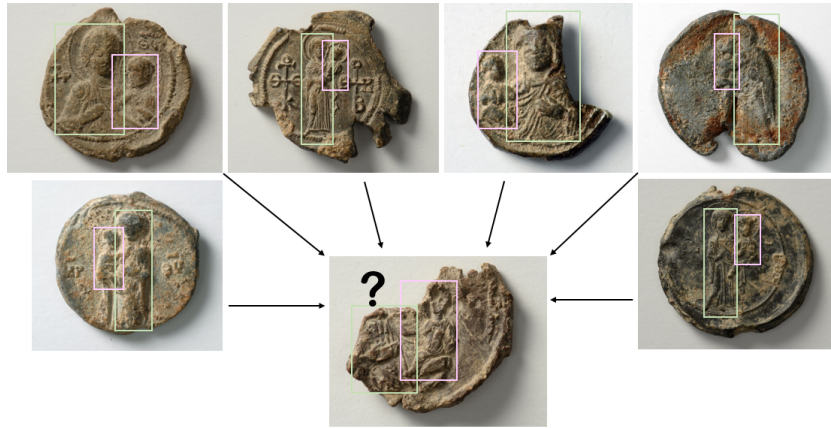


Figure 1: Example of seals depicting "Virgin Mary with the Christ Child".

We show the usefulness (and also the complexity) of spatial modeling in Byzantine seals through an example. Unlike medical images, where an organ can be deformed or slightly displaced by a tumor, in Byzantine seals, the objects do not necessarily have a predefined place. In the examples in Figure 1, the different seals bearing the Virgin Mary holding the Christ child, we notice that the child is on the left, on the right, up on the right, etc. In such cases, proximity and relative size could be more relevant than directional position.

4 Profile of applicant

The candidate must fit the following requirements:

- Registered in Master 2 or last year of Engineering School (or equivalent) in Computer Science.
- Advanced skills in Python programming are mandatory.
- Good skills in Machine Learning & Deep Learning using related libraries (scikit-learn, Tensorflow, Pytorch, etc.) will be useful for the last part of the internship.

5 Research environment

The proposed internship will be carried out within the LFI (Learning, Fuzzy and Intelligent systems) team at LIP6. It will be part of the ANR BHAI project starting in October 2021 for 4 years. **Therefore, there is a great opportunity to continue with a PhD in our team on the same topic/project.** Indeed, if successful, this internship could be the starting point of a PhD thesis. Isabelle Bloch and Victoria Eyharabide will jointly supervise the PhD candidate to work on new approaches combining knowledge graph embeddings [2] and mathematical modeling of spatial relationships [1] for image understanding.

6 Application

Applications should include a CV, academic records, personal projects (e.g. github repo) and a motivation letter, and should be sent (in pdf format) to Isabelle Bloch isabelle.bloch@sorbonne-universite.fr and Victoria Eyharabide maria-victoria.eyharabide@sorbonne-universite.fr

References

- [1] Isabelle Bloch. Fuzzy sets for image processing and understanding. *Fuzzy Sets Syst.*, 281(C):280–291, dec 2015.
- [2] Victoria Eyharabide, Imad Eddine Bekkouch, and Nicolae Dragoş Constantin. Knowledge graph embedding-based domain adaptation for musical instrument recognition. *Computers*, 10(8):94, 2021.
- [3] Victoria Eyharabide, Vincent Lully, and Florentin Morel. Musickg: Representations of sound and music in the middle ages as linked open data. In *Semantic Systems*, pages 57–63, 2019.