# Semantic Motif Segmentation of Archaeological Fresco Fragments

A. Enayati*, L. Palmieri*, S. Vascon, M. Pelillo, S. Aslan

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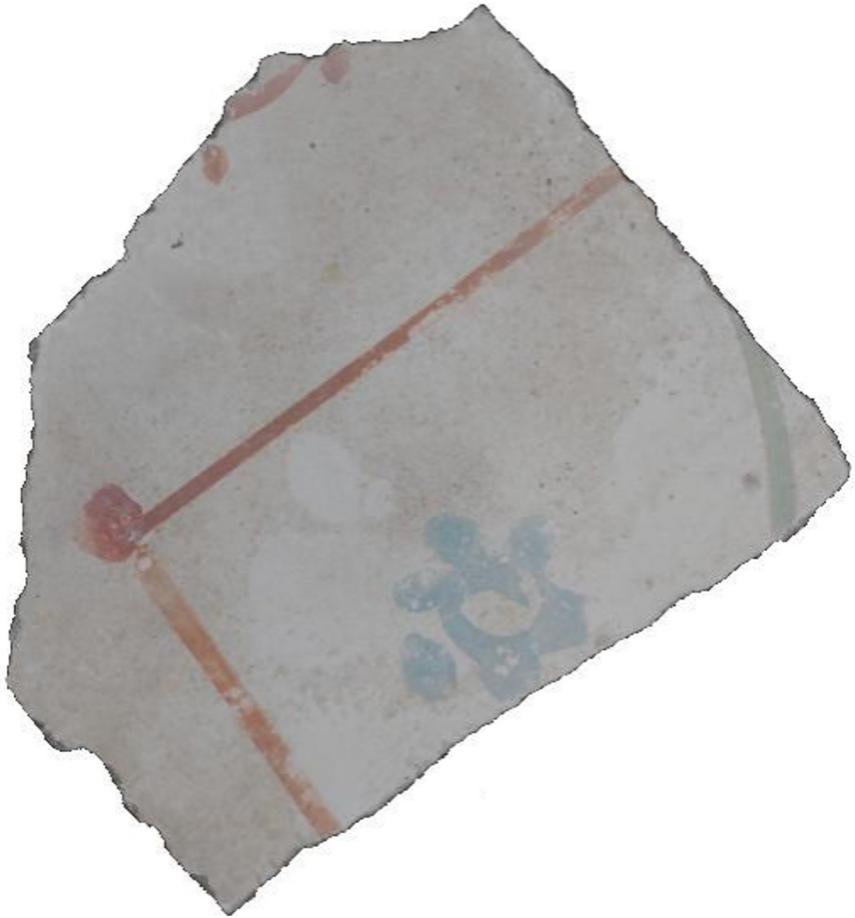
Università Ca'Foscari Venezia

RePAIR

CV ML LAB
Computer Vision & Machine Learning

# Motivations



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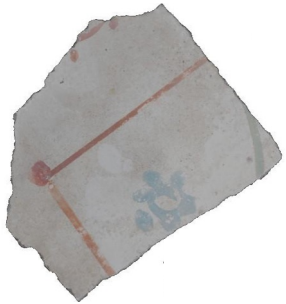

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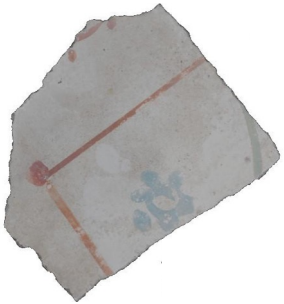

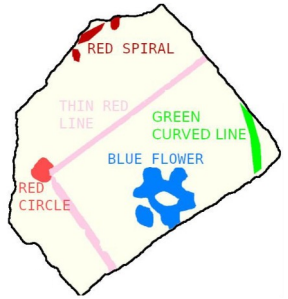


Locating motifs and predicting their class provide a high-level semantic representation of fragments.

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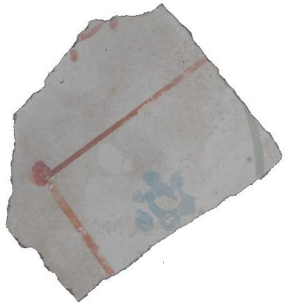
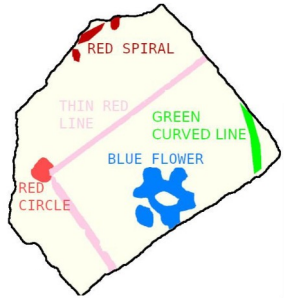
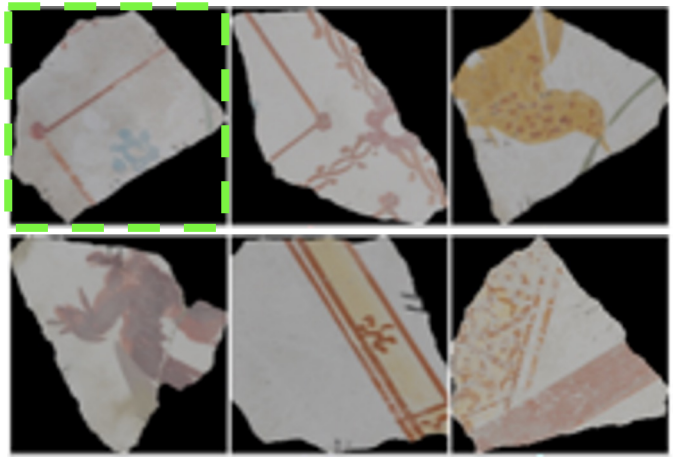





Locating motifs and predicting their class provide a high-level semantic representation of fragments.

Why?

- Fragment recognition



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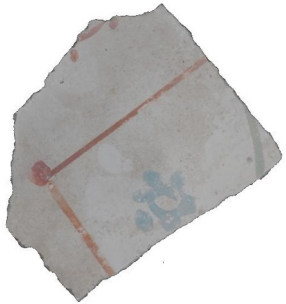
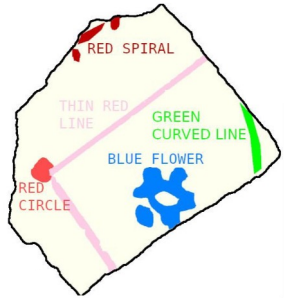





Locating motifs and predicting their class provide a high-level semantic representation of fragments.

Why?

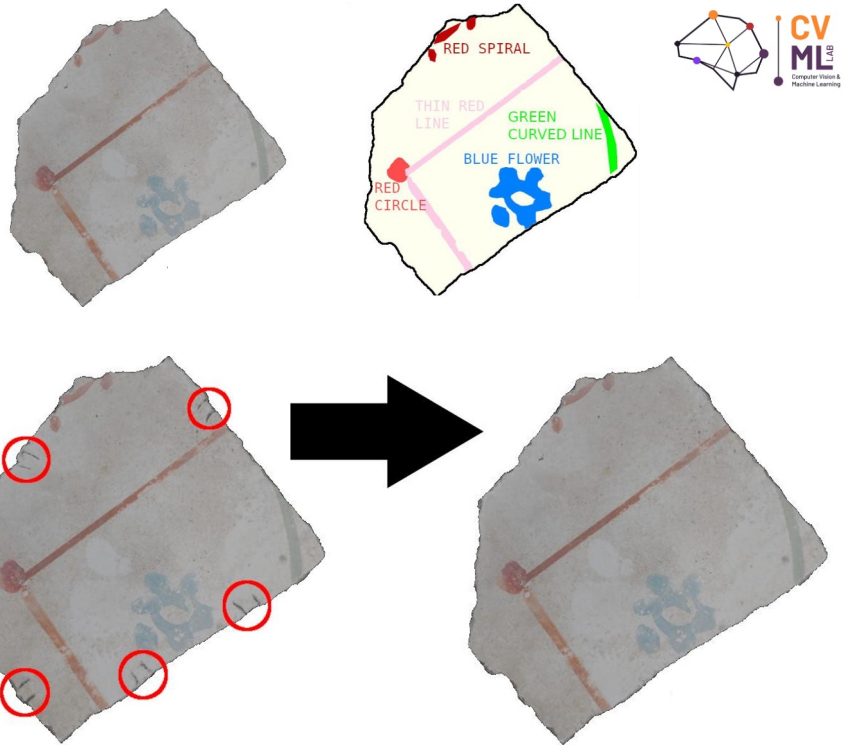
- Fragment recognition
- Fragment Clustering

# Motivations

Locating motifs and predicting their class provide a high-level semantic representation of fragments.

Why?

- Fragment recognition
- Fragment Clustering
- Targeted inpainting and restoration



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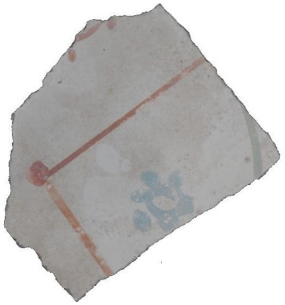
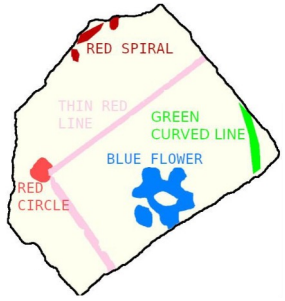




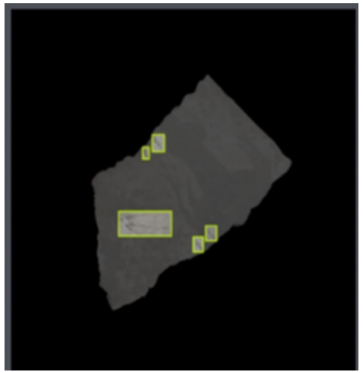

Locating motifs and predicting their class provide a high-level semantic representation of fragments.

Why?

- Fragment recognition
- Fragment Clustering
- Targeted inpainting and restoration
- Fresco reconstruction

# Datasets

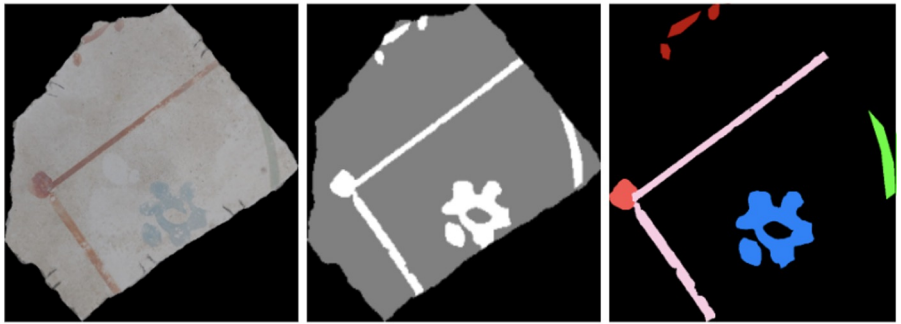
## BoFF Dataset



Curated for the task of restoration of manual annotations on fresco fragments

- 115 images
- Bounding box annotations of black-marks

## MoFF Dataset



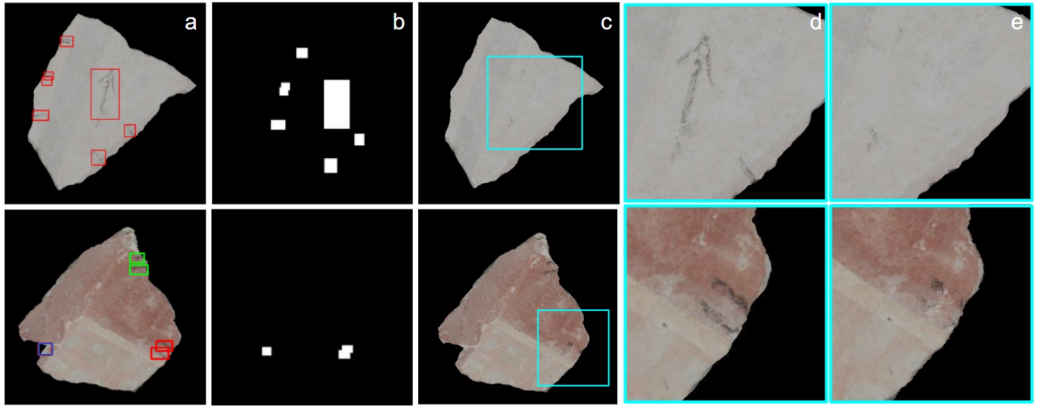
Curated for semantic segmentation of motifs on fresco fragments

- 3-class annotation (scenario 1)
- 12-class annotation (scenario 2)

# Black mark removal

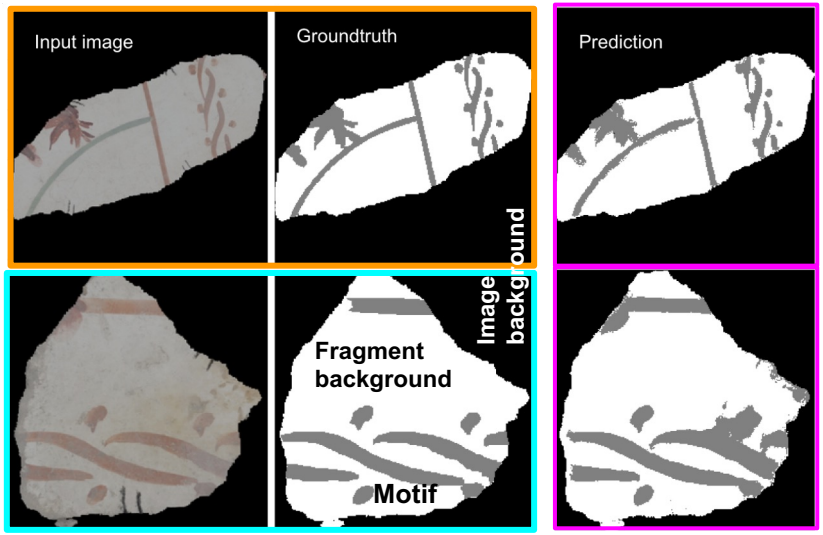
The table below shows numerical results of YOLOv5 model for detecting black marks on the fresco fragments.

| Model | Precision | mAp0.5 | TP | FP | FN |
|---|---|---|---|---|---|
| YOLOv5 | 0.741 | 0.596 | 28 | 3 | 11 |



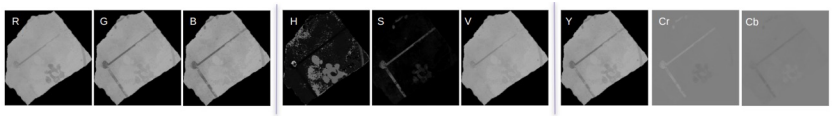

Criminisi [1] exemplar-based inpainting is used in two iterations to eliminate detected marks.

# Semantic Segmentation of Background and Motifs



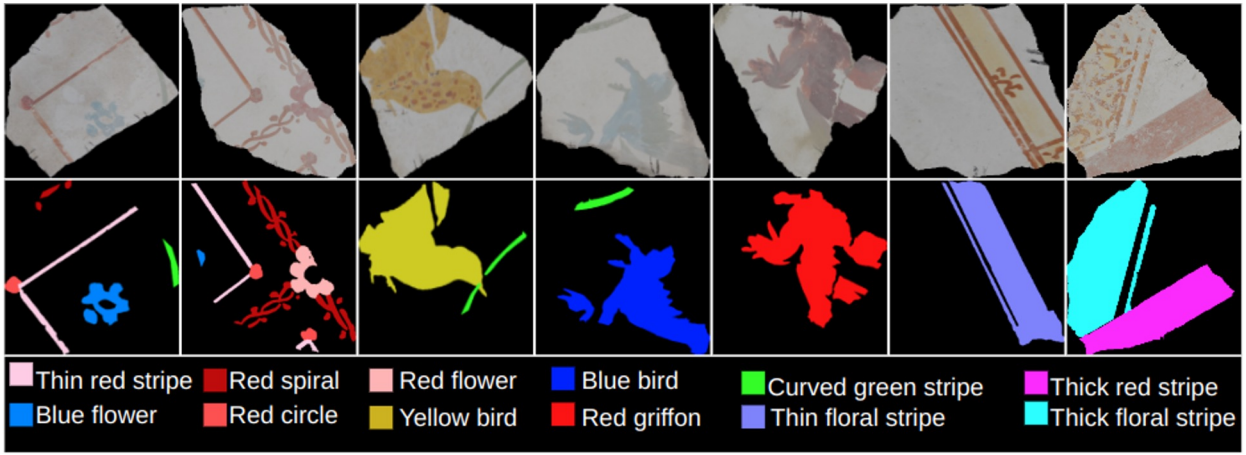

**3-class** segmentation problem is studied using:

- **Original** and **modified U-NET** architectures
- Input images in various **color spaces** and **image enhancement** schemes



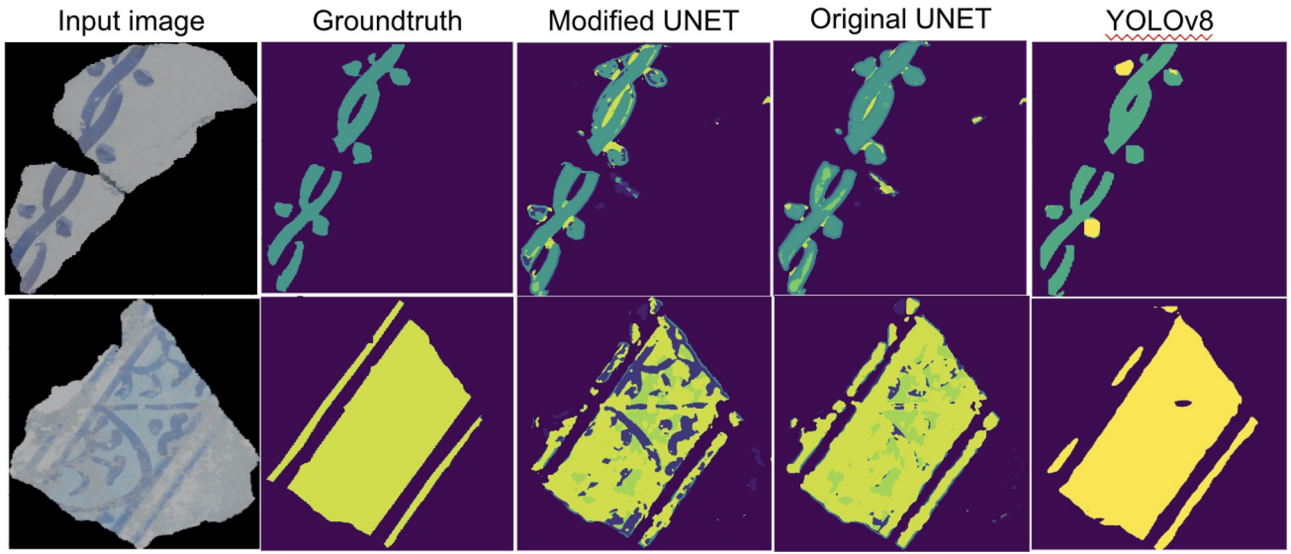
# Semantic Motif Segmentation

Herein we address **a more challenging** task of semantically segmenting motifs into 12 distinct classes.



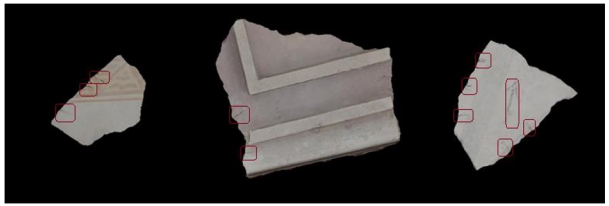
# Semantic Motif Segmentation

- We used both UNET and YOLOv8 for semantic segmentation of motifs.

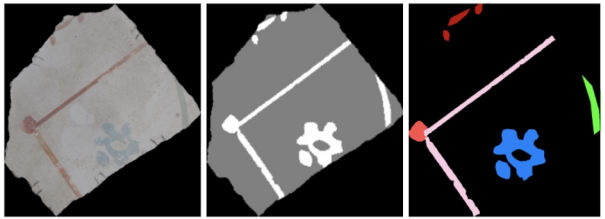


# Conclusions

- **We introduced two new datasets of curated archaeological data**
- We define and provide a baseline for two archaeology-related tasks
- We explored the diversity of pictorial contents on the fragments and the performances of YOLO and UNet



**BoFF Dataset**
(Bounding Boxes)



**MoFF Dataset**
(pixel-wise masks)

This work is part of a project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No.964854.

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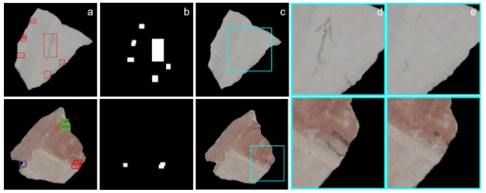
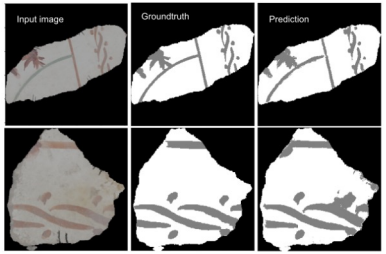



Task 1: **Restoration of Manual Annotations**
(Mark Removal + Inpainting)




Task 2: **Fragment Semantic Segmentation**
(Fragments and Motif-only)

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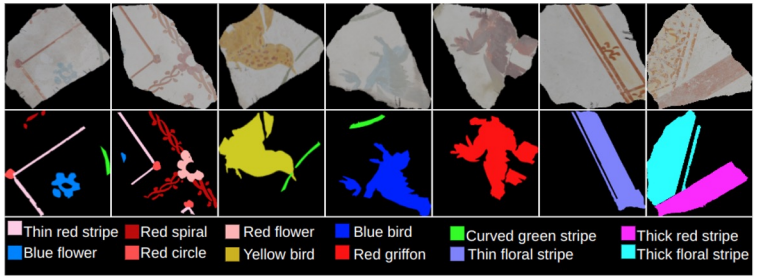


The range of diverse elements in the pictorial content of the fragments

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