

# Computational Diagnostic Method of the Organisms Causing Mycetoma Based on Histology

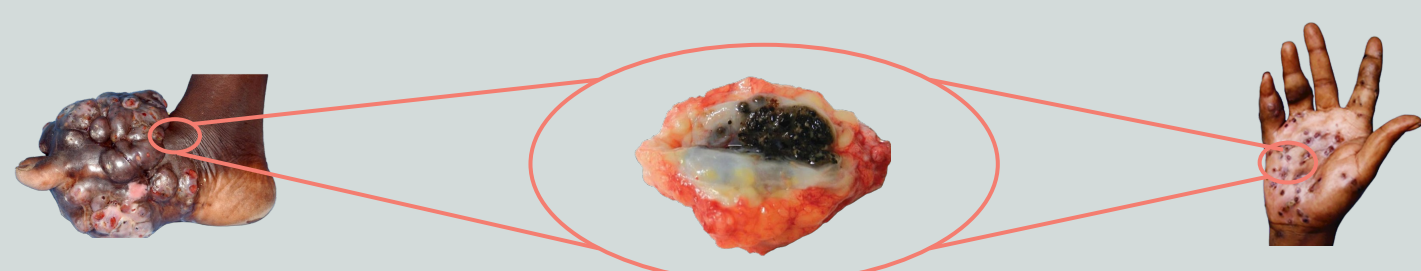
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## INTRODUCTION

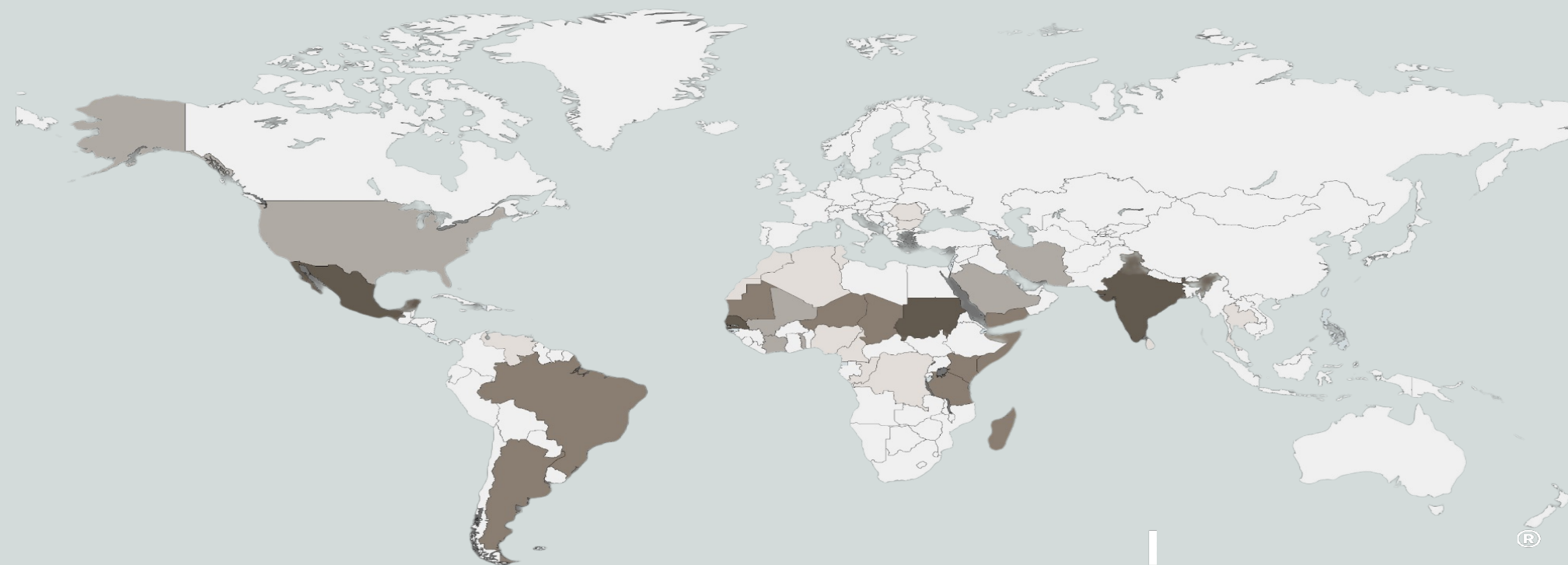
### The Disease

- Mycetoma is a subcutaneous infection that leads to massive deformities and disabilities.<sup>(1)</sup>
- Mycetoma is caused by bacterial (Actinomycetoma AM) or fungal (Eumycetoma EM).
- The treatment of mycetoma **depends** on the accurate identification of the causative agents.<sup>(1,2)</sup>



### Geographical Distribution

- Tropical and subtropical regions (The Mycetoma belt)



### Aim of Our Project

To develop an **automated diagnostic method** that could reduce the need for expert pathologists in non-specialized clinical centres to perform *histological analysis*.

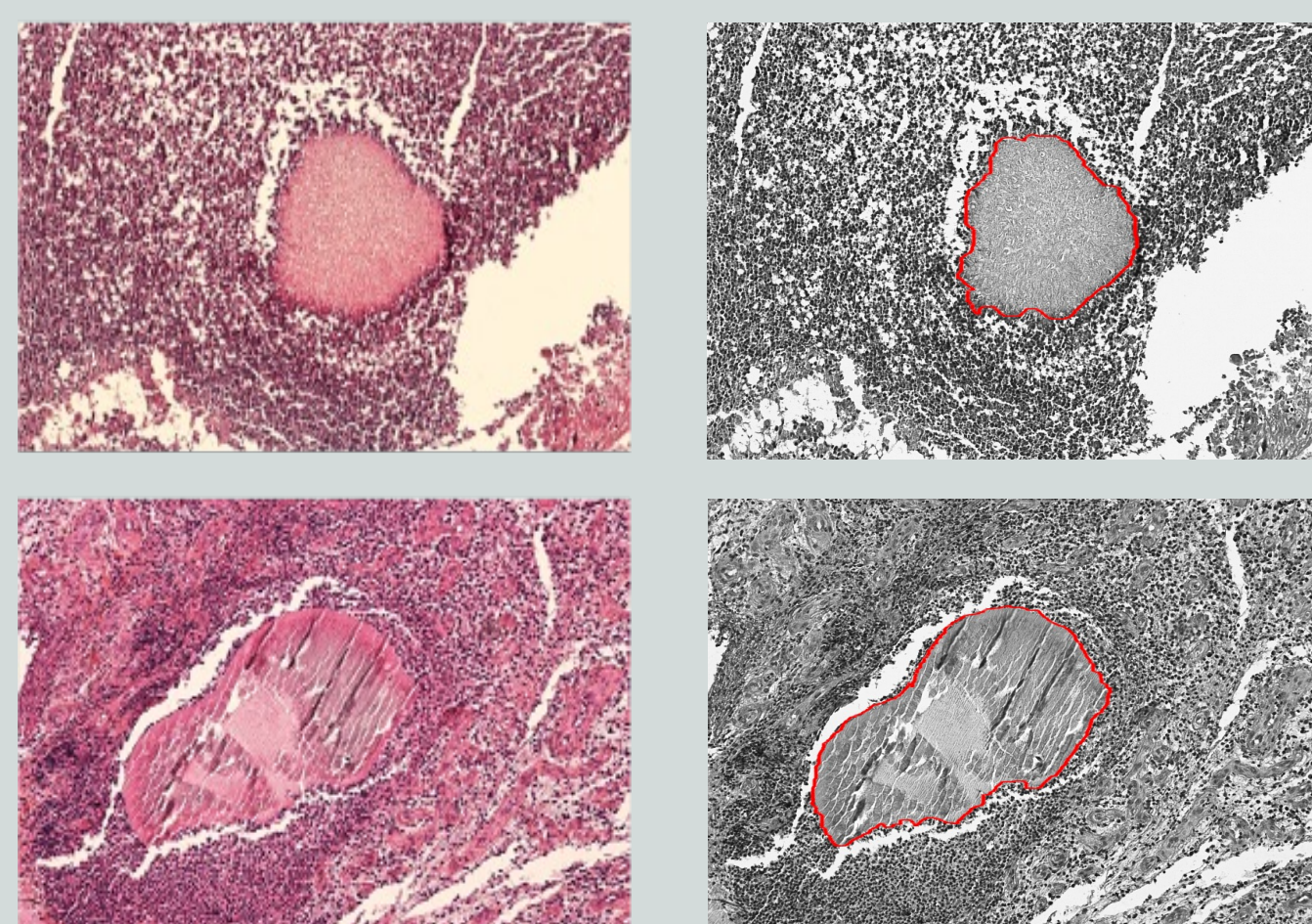
### Laboratory Diagnosis

- Identification of causative agents relies on the analysis of grains that develop in infected tissues.
- Grain culture is a core tool but it is time consuming.
- Molecular techniques provide authenticated results, it is expensive.
- Cytological and Histopathological are rapid, cheap and commonly used in rural areas.
- **HISTOPATHOLOGY** is considered to be an efficient, cost and time-effective tool for mycetoma diagnosis in endemic areas.<sup>(2,3)</sup>

## MATERIAL AND METHOD

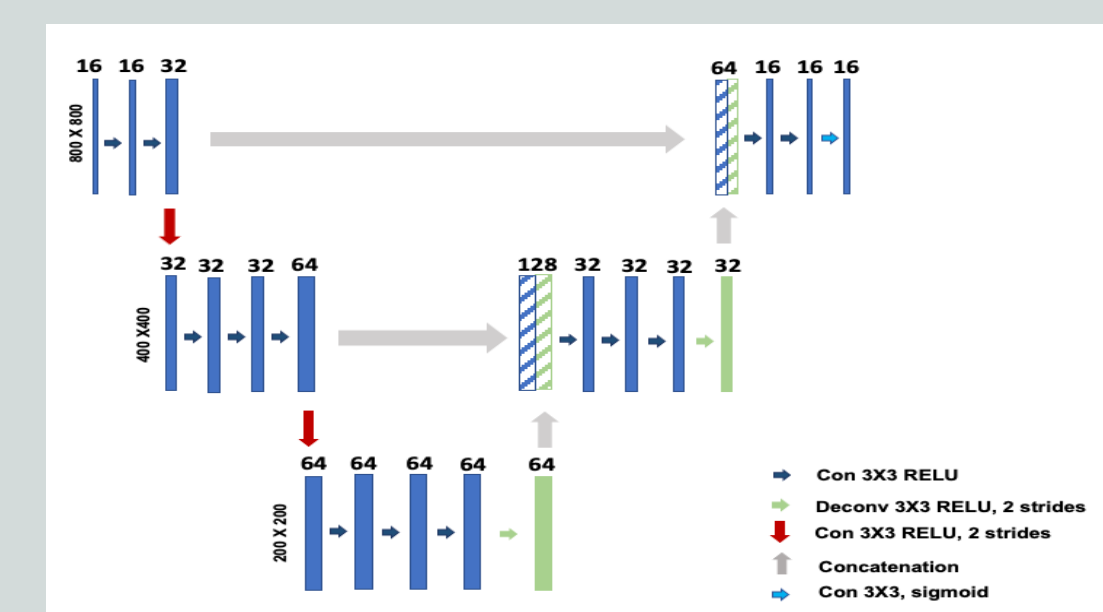
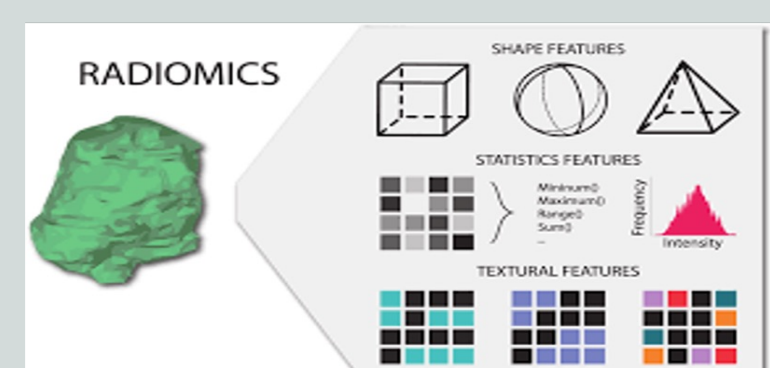
### Dataset

- Tissue biopsies of **142 mycetoma** patients with **80 EM** and **62 patients** with AM.
- Tissue sections were stained **with Haematoxylin and Eosin stain (H&E)**.
- Images were captured in RGB colour space with a magnification of **10x**.
- *Nikon Eclipse 80i* microscope was used for acquisition.
- The dataset contained a total of **864** tissue grain microscopic grain images.



### Classification/Diagnosis

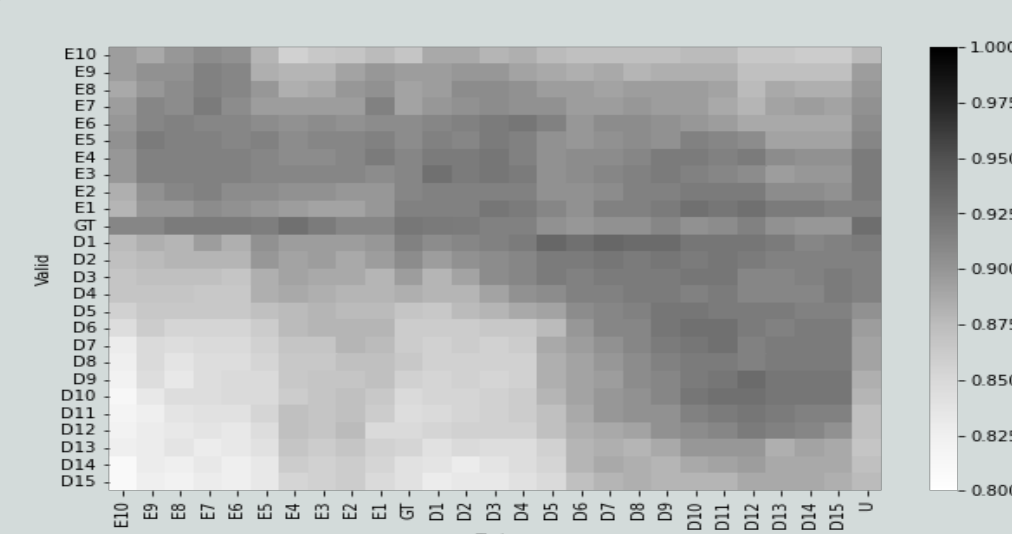
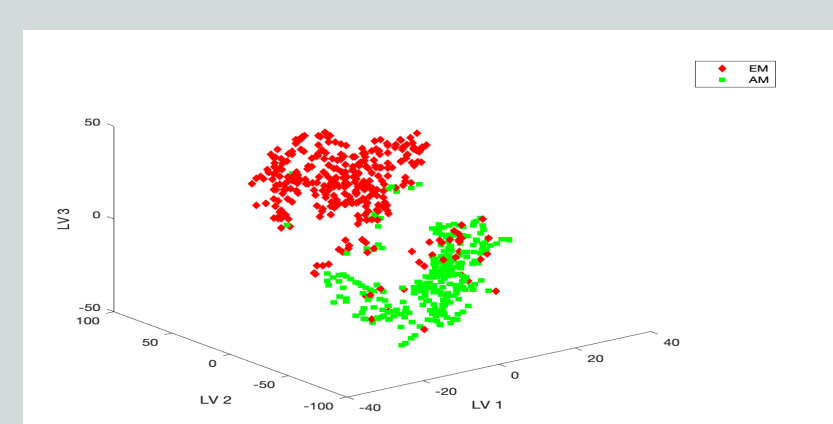
- Using **RADIOMICS** in conjunction with **Partial least squares discrimination analysis (PLS-DA)**, we proposed a model to discriminate between AM and EM effectively.
- The model is built from 102 *radiomics features* extracted from manually segmented grains.
- To further increase the automatization of the method we proposed a **CNN model for grain segmentation**.
- Our proposed model is a reduced version of Unet with small number of weights in each layer.



## RESULTS

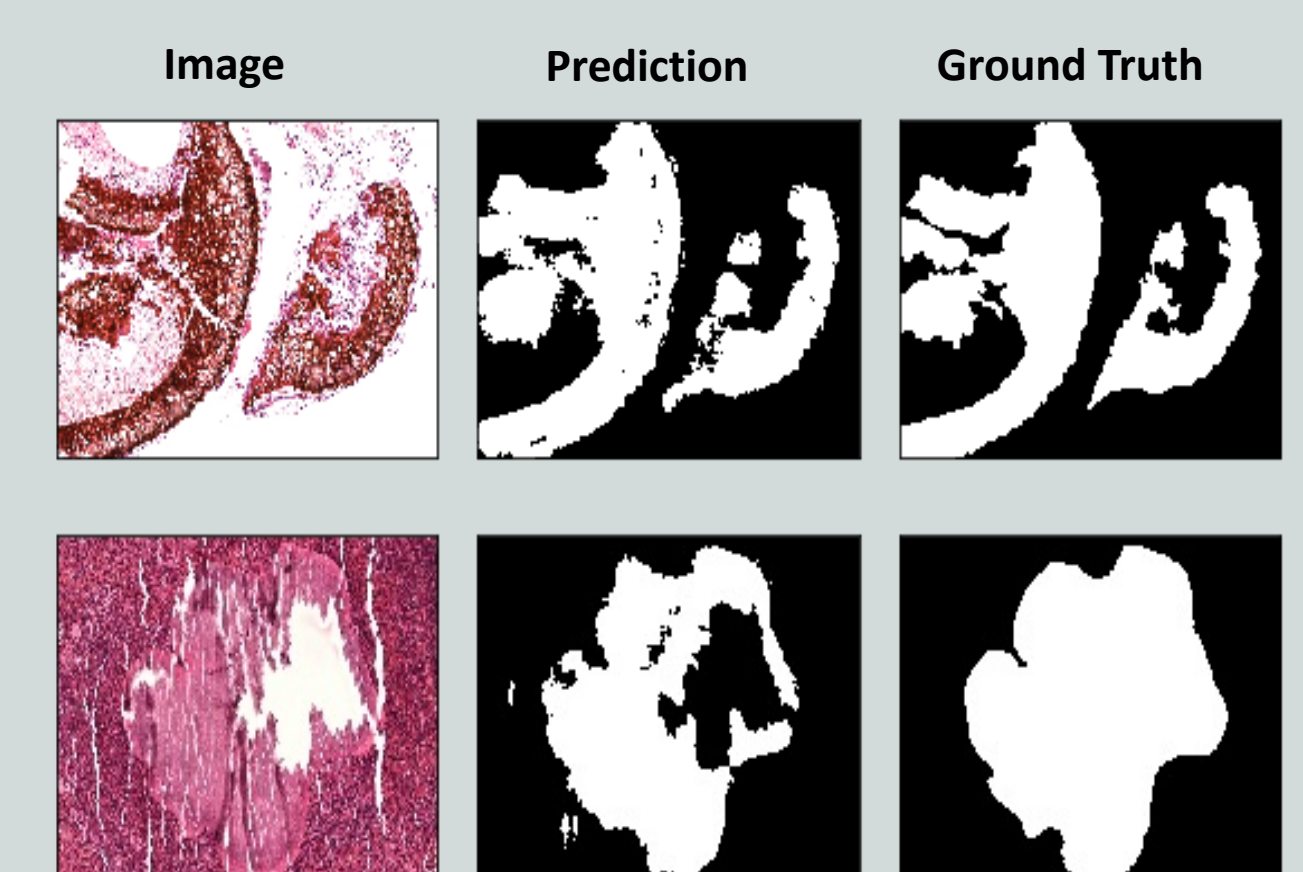
### Manual Segmentation

- From **manually segmented grains**, our method achieved mycetoma type identification with an accuracy of **91.8%**.
- This is comparable to the score obtained by experts (92.4%)<sup>(4)</sup>.
- The model is assessed against manual segmentation errors.



### CNN Segmentation

- The network achieved a DICE index of 0.7626 and 94.9% accuracy on segmentation task.
- The segmentation is assessed to classify the mycetoma agents by using radiomic model.
- The diagnosis accuracy was **88%** for the integrated automated segmentation and radiomics model.



## CONCLUSION

- The neglected effective diagnostic tools currently used for mycetoma diagnosis require expert physicians and/or expensive hardware equipment.
- In this work, we introduced a novel, simple, low-cost computational method that could be integrated into routine histopathological diagnosis procedures in endemic areas. The proposed method uses radiomics in conjunction with PLS-DA to effectively discriminate between actinomycetoma and eumycetoma.
- With the manually segmented grains, our model has a performance similar to experts. The accuracy is slightly decreased but remains close with auto-segmented grains.
- Further work will aim at better avoiding false positive grain segmentation to increase the robustness of the automated approach.

References:  
(1) World Health Organization (2022) Neglected tropical diseases. Available at: [http://www.who.int/neglected\\_diseases/diseases/en/](http://www.who.int/neglected_diseases/diseases/en/)

(2) A. A. Ahmed, W. van de Sande, and A. H. Fahal, "Mycetoma laboratory diagnosis," *PLoS Negl. Trop. Dis.*, vol. 11, no. 8, p. e0005638, 2017.

(3) W. W. J. van de Sande, A. H. Fahal, M. Goodfellow, O. Welsh, E. E. Zijlstra, and others, "Merits and pitfalls of currently used diagnostic tools in mycetoma," *PLoS Negl. Trop. Dis.*, vol. 8, no. 7, p. e2918, 2014.

(4) E. E. Siddig et al., "The Accuracy of Histopathological and Cytopathological Techniques in the Identification of the Mycetoma Causative Agents," *PLoS Negl. Trop. Dis.*, vol. 13, no. 8, p. e0007056, 2019.