

Automated Analysis of Fungal-Infected Tissue using Deep Learning

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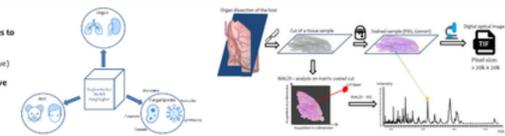
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1. Experimental setup

- Combine optical image analysis with MALDI images to detect fungal infected regions
- Learn one model for each staining method:
 - Gomori (Gomori trichrome stain used on muscle tissue)
 - PAS (Periodic acid-Schiff reaction)
- Classify mass spectrum (MS) according to respective fungus species



2. Optical image segmentation

Deep Learning of Convolutional Neural Networks (CNN)

Training

Input: Images (Fungi, Control, PAS, Training, Test)

Output: CNN

Testing/Application

Segmentation results

(A) Test region of manually annotated fungus infected tissue

(B) Network prediction: white regions correspond to high probability P of fungal infected tissue

(C) Complete tissue sample: green regions represent the annotated fungus

(D) Network inference for the entire sample image

- Network - metric value on test images: Dice Coeff (DC) = $\frac{2TP}{2TP + FP + FN}$
- Network - loss value on test images: $L(x, y) = \sum_{i=1}^n \sum_{j=1}^n (x_{ij} - y_{ij})^2 + DC = 0.3667$

3. Interface for optical image – MALDI image

Issue:

- We need to correlate MS coordinates with the corresponding position in the optical tissue image
- No free or commercial software solution existing

Approach:

- Approximate assignment of each MS to the original tissue image
- Use of an interactive graphical user interface (GUI)



4. Classification of MALDI-imaging

- MALDI images is 2D image with 50 µm resolution (e.g. 100 x 100 MS)
- Each MS contains values for m/z (mass-to-charge ratio)
- Each value represents an intensity

Sample MS: Dimensionality per MS = 8000

MS for whole 2D image

Dimension reduction by Autoencoder

Vector with 6 features for each MS

Classify each MS with Random forest classifier by using probability map as label

Legend:

- Background
- Normal tissue
- Fungal infected tissue

Preliminary result

- Overlay of stained tissue and MALDI image
- Light Green: Background
- Dark Green: Annotated fungal infected tissue on stained images
- Purple: Tissue
- Red: MS classified with fungus

5. Conclusions

- Deep learning of neural networks allows to identify fungal infected tissue
- Novel approach for the registration of optical tissue image and MALDI image
- Machine learning models allow to associate fungal infected tissue with MS spectra

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