

# Image Based Detection of Nail Melanoma Using Deep Learning Techniques

Ayca Öztürk - University of Würzburg, Germany

## Introduction

- Nail Apparatus Melanoma (NAM):** a rare but serious type of melanoma (skin cancer)
- Key Sign:** pigmented nail band
- Challenge:** delayed diagnosis, due to unclear symptoms (e.g., subtle signs, similar to other diseases)
- Outcome:** poorer prognosis (e.g., surgery, amputation)
- AI:** can support early diagnosis

## Motivation & Aim

### Why Deep Learning?

- Nail diseases are image-based
- Clinical images are easy to collect
- Deep Learning achieves expert-level accuracy

### Aim of the project:

- Multi-stage deep-learning pipeline for automatic NAM detection

## Methodology

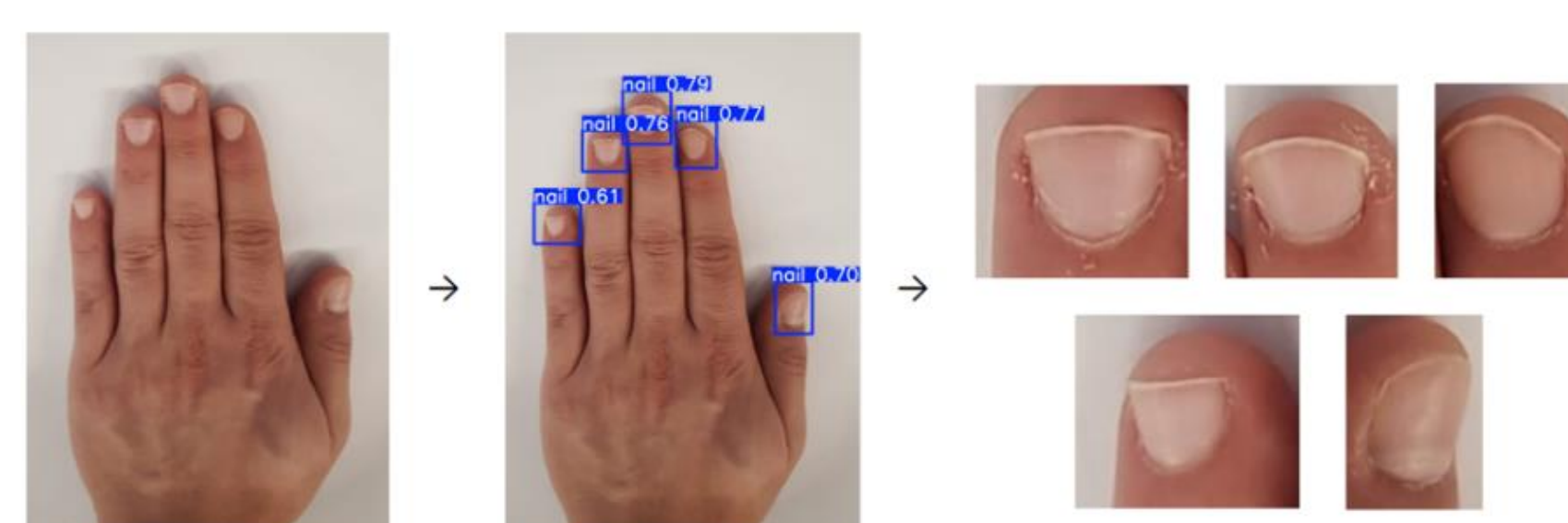
### 1. Dataset

**Sources:** Universitätsklinikum Würzburg, Kaggle, Google Images

Class	Number of Images
Nail Melanoma	473
Healthy	491
Onychomycosis	574
Nail Psoriasis	684
Onycholysis	110
Beau's Lines	102
Koilonychia	38
Leukonychia	31
<b>in total</b>	<b>2503</b>

### 2. Nail Region Detection using YOLOv8

- YOLOv8 detects bounding boxes for nails
- Nails get cropped & resized for standardization



### 3. Training Deep Learning Classification Models

**Classes:** healthy vs melanoma

#### CNNs

- ResNet-18
- VGG-19
- EfficientNet-B0
- Custom CNN

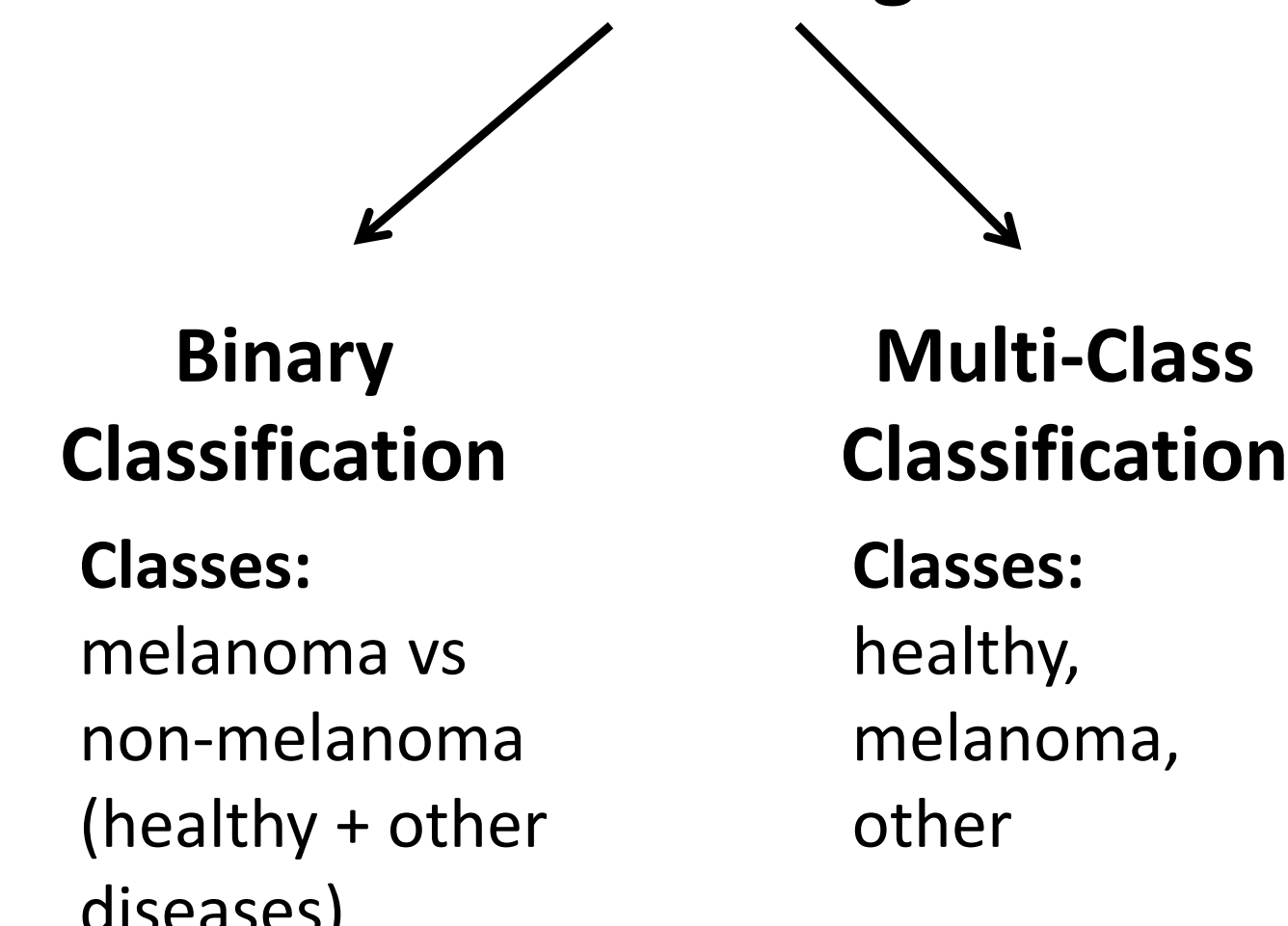
#### ViTs

- ViT-B/16

#### Hybrid CNN

- YOLOv8-cls

### 4. Evaluating the Models in Binary and Multi-Class Settings

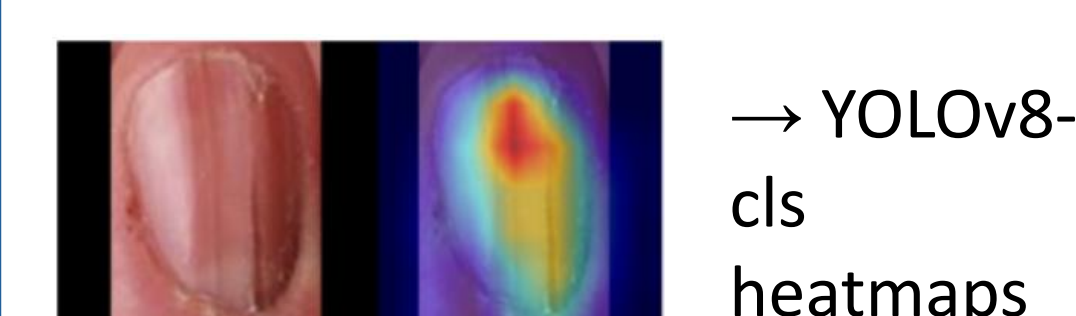
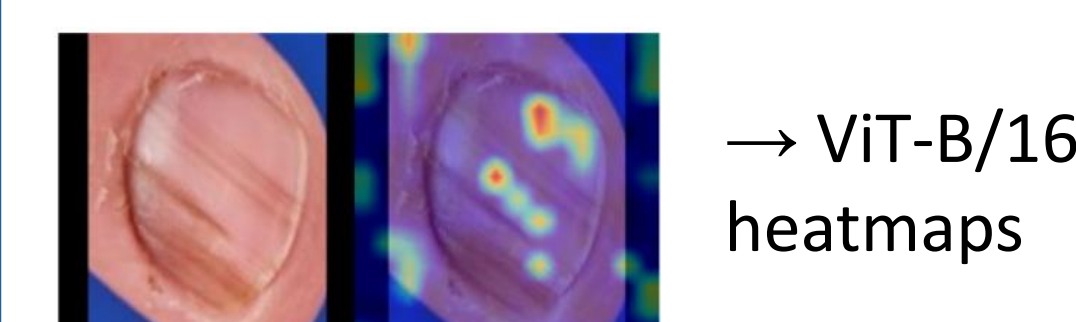


### 5. Fine-tuning & Metrics

- Best Models, which are fine-tuned:** ViT-B/16, YOLOv8-cls
- Tuned Hyperparameters :** epochs, batch size, learning rate
- Evaluation Metrics:** confusion matrix, precision, recall, F1-score (balance between precision and recall), accuracy

### 6. Explainable AI (XAI)

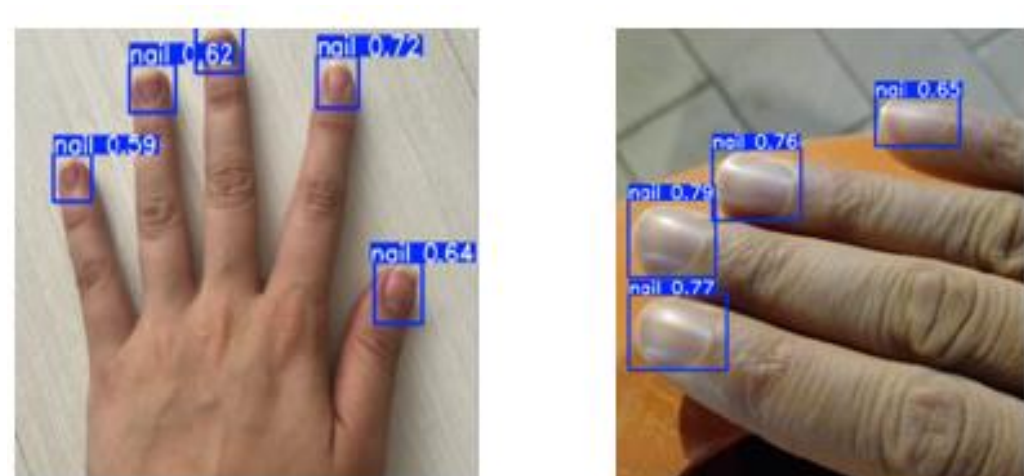
- Generation of heatmaps to visualize model focus regions



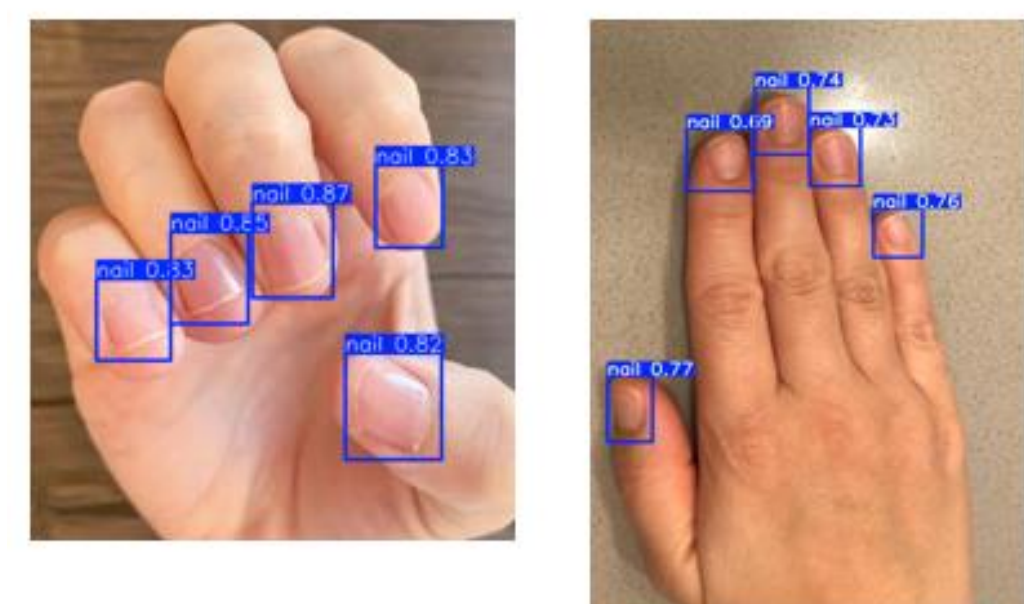
## Results

### 1. Nail Region Detection Results

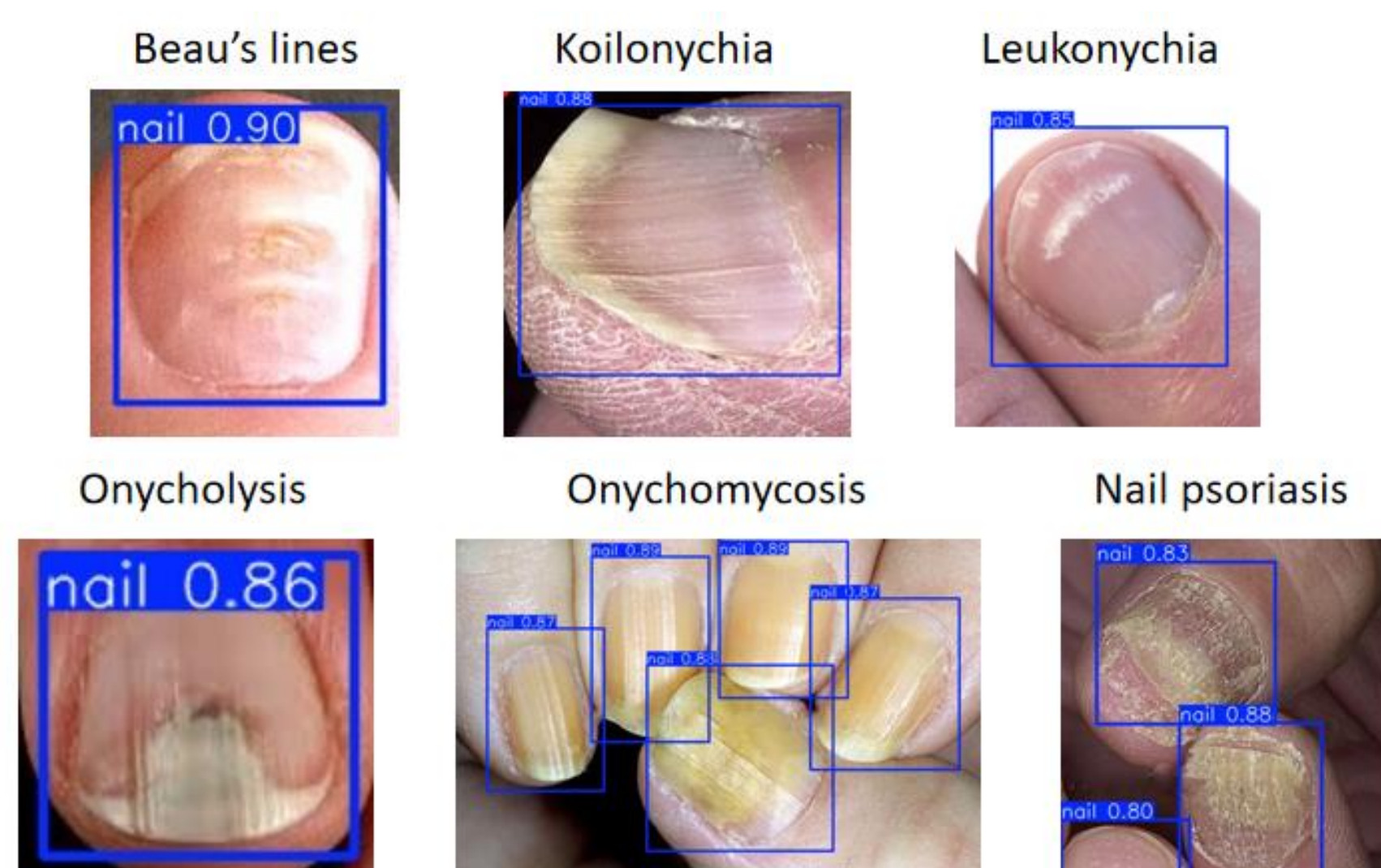
#### I. Bounding box detections of healthy nails



#### II. Bounding box detections of nails with melanoma



#### III. Bounding box detections of nails with different diseases



### 2. Classification Performance of the models (healthy vs melanoma nails)

Model	NAM Precision	NAM Recall	NAM F1-Score	Accuracy
ResNet-18	0.940	0.902	0.921	0.960
VGG-19	0	0	0	0.747
EfficientNet-B0	0	0	0	0.747
Custom CNN	1.000	0.313	0.472	0.830
ViT-B/16	1.000	0.990	1.000	0.990
YOLOv8-cls	1.000	0.992	0.996	0.998

→ ResNet-18, ViT-B/16 and YOLOv8-cls are selected for further experiments

### 3. Classification Performance of the models in binary vs multi-class configurations

#### I. Multi-Class Classification Results

Model	Class	Precision	Recall	F1-score	Accuracy
ViT-B/16	Healthy	0.97	0.98	0.98	0.97
	Melanoma	0.96	0.94	0.95	
	Other	0.97	0.97	0.97	
YOLOv8-cls	Healthy	0.98	0.99	0.98	0.98
	Melanoma	0.96	0.95	0.96	
	Other	0.99	0.97	0.98	
ResNet-18	Healthy	0.91	0.97	0.94	0.90
	Melanoma	0.83	0.71	0.76	
	Other	0.91	0.90	0.91	

- good performance in both settings
- accuracy remained stable
- ViT-B/16 and YOLOv8-cls** outperformed ResNet-18
- melanoma recall** (how many true cases the model detects) decreased in the binary setting → **multi-class classification** was selected

#### II. Binary Classification Results

Model	Class	Precision	Recall	F1-Score	Accuracy
ViT-B/16	melanoma	0.97	0.92	0.95	0.98
	non melanoma	0.98	0.99	0.99	
YOLOv8-cls	melanoma	0.97	0.93	0.95	0.98
	non melanoma	0.98	0.99	0.99	
ResNet-18	melanoma	0.88	0.36	0.52	0.88
	non melanoma	0.88	0.99	0.93	

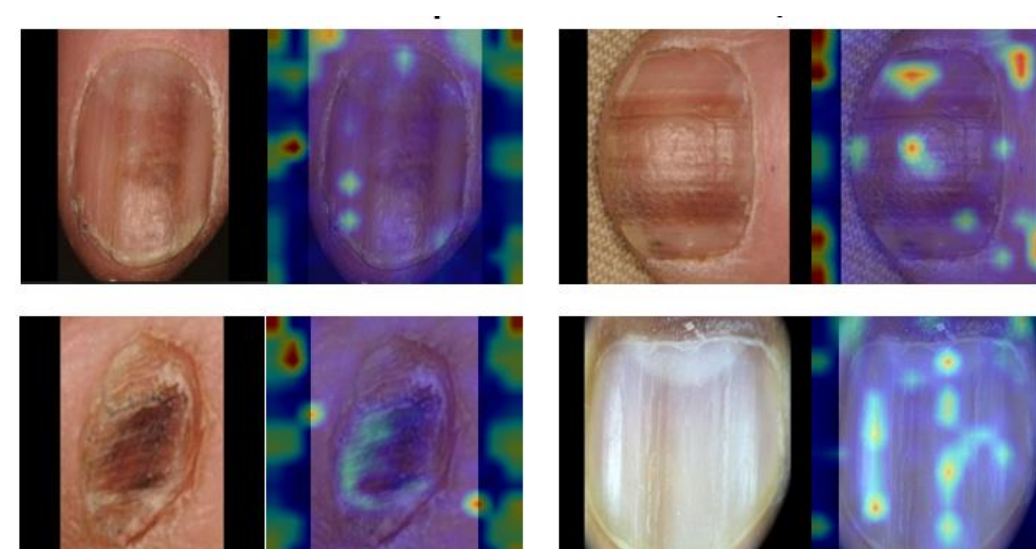
### 4. Fine-Tuning Results of the selected models

Model	F1-Score (healthy)	F1-Score (melanoma)	F1-Score (other)
ViT-B/16	0.98	0.97	0.98
YOLOv8-cls	0.99	0.96	0.98

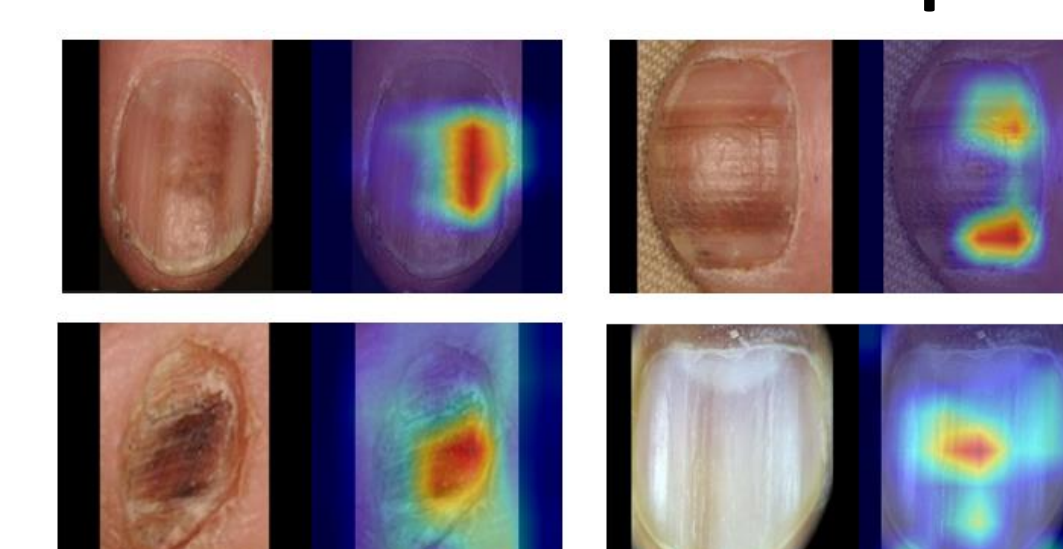
- ViT-B/16's accuracy:** from 97% to 98%
- YOLOv8-cls's accuracy:** from 98,2% to 98,6%

### 5. Explainable AI: Heatmaps

#### I. ViT-B/16 heatmaps



#### II. YOLOv8-cls heatmaps



- diffuse & distributed heatmaps across the nail, highlighting multiple areas
- localized patterns, focusing on salient regions (e.g., pigmentations, lesions, irregular structures)

## Conclusion

- The models achieved a high accuracy
- Multi-Class classification provided better results
- Heatmaps (XAI) confirmed focus on clinically relevant regions

→ Deep Learning techniques have strong potential to support earlier NAM detection in clinical practice