AI IN DERMATOLOGY SUMMIT 2026 Vienna, Austria · September 29, 2026

# Adapting a Multimodal Vision Foundation Model as a Universal Feature Extractor for Nail Pigmentation Diagnosis

*A Non-Linear Probing Approach Using PanDerm*

Dr. Harald Kittler[1] & Sebastian Hochreiter, MSc[1]

[1] Medical University of Vienna, Department of Dermatology, Vienna, Austria

TECHNICAL ADVANCES & RESEARCH FRONTIERS Poster Presentation

BACKGROUND

## The Diagnostic Challenge

Nail pigmentation disorders present a diagnostically challenging spectrum, including subungual melanoma, hemorrhage, melanocytic nevi, and melanocytic activation. Accurate differentiation is critical given the prognostic cost of delayed melanoma diagnosis. Existing AI tools are built for cutaneous lesions and lack adaptation to the nail unit. PanDerm, a multimodal vision foundation model pre-trained on over 2 million dermatological images from 11 institutions via masked autoencoding, offers a frozen feature space that could serve as a universal extractor for nail lesion classification without full fine-tuning.

METHODS

## Frozen Embeddings, Two Probes

Clinical and onychoscopic images were passed through PanDerm's frozen encoder to generate 1024-dimensional embeddings; no model weights were updated. Zero-shot t-SNE assessed intrinsic class separability across four diagnoses. Two probing strategies were then compared: linear probing (logistic regression) and non-linear probing (k-Nearest Neighbours), to test whether class boundaries in embedding space require non-linear decision boundaries.

COHORT

## Dataset Composition

**373** Total Lesions

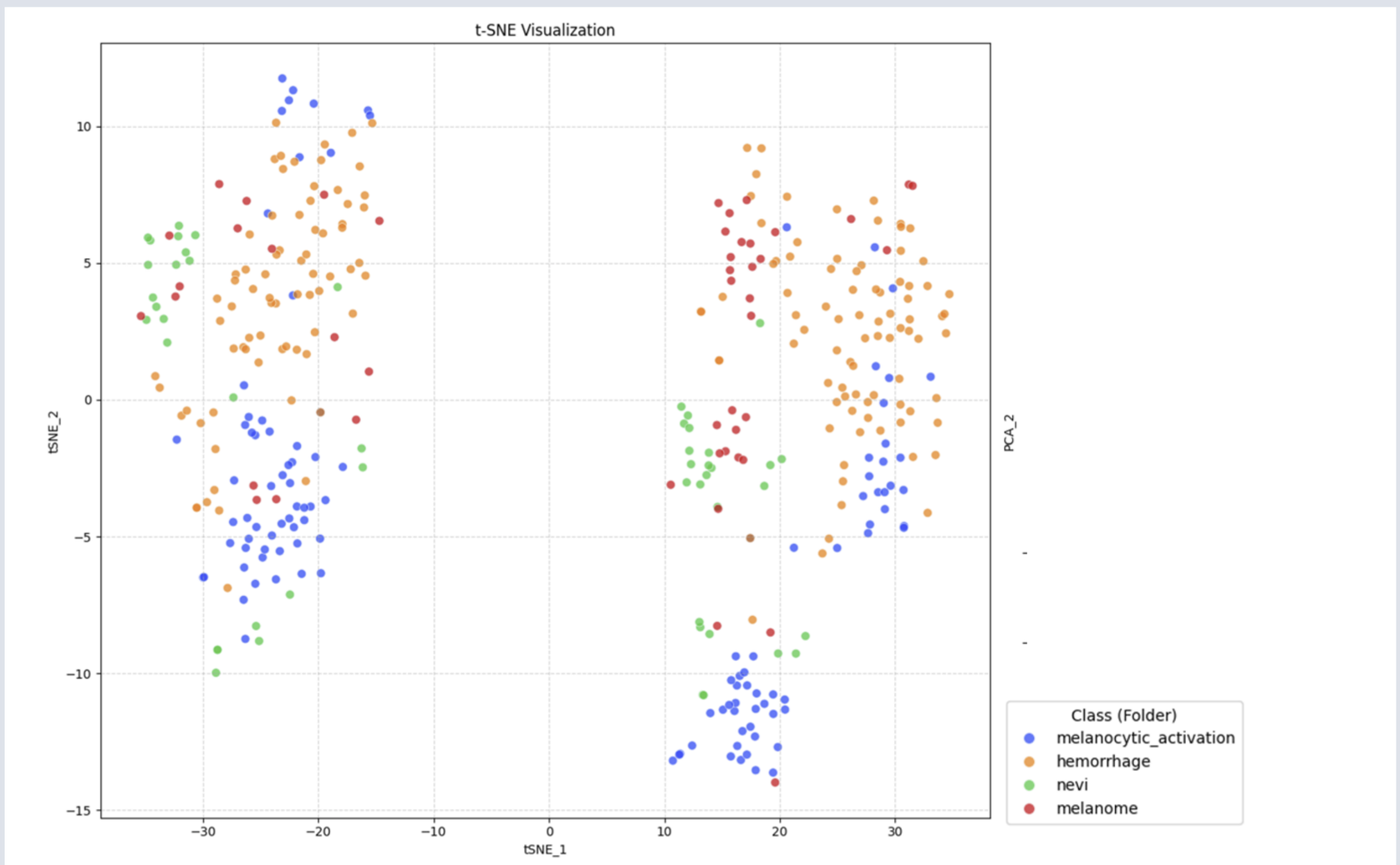
**4** Diagnostic Classes

Lesions per Diagnostic Class

**159** Hemorrhage **118** Melanocytic Activation **49** Nevi **47** Melanoma

FIGURE 1: COMPOSITE PANEL

Panel A: Zero-Shot t-SNE Embedding Visualization

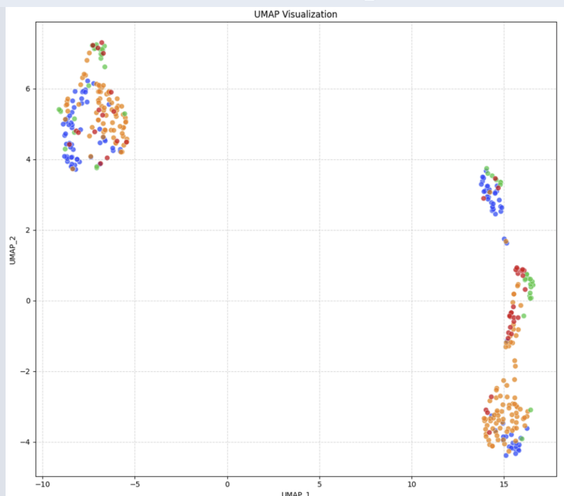



Panel B: Probing Performance Comparison

| Metric | Linear Probe | k-NN (Non-linear) | 95% CI (k-NN) |
|---|---|---|---|
| **Accuracy** | 0.43 | **0.71** | 0.64–0.78 |
| **Macro F1** | – | **0.66** | 0.59–0.72 |
| F1 (Hemorrhage) | – | 0.79 | 0.71–0.86 |
| F1 (Melanocytic Activation) | – | 0.65 | 0.55–0.74 |
| F1 (Nevi) | – | 0.62 | 0.52–0.71 |
| F1 (Melanoma) | – | 0.57 | 0.42–0.71 |

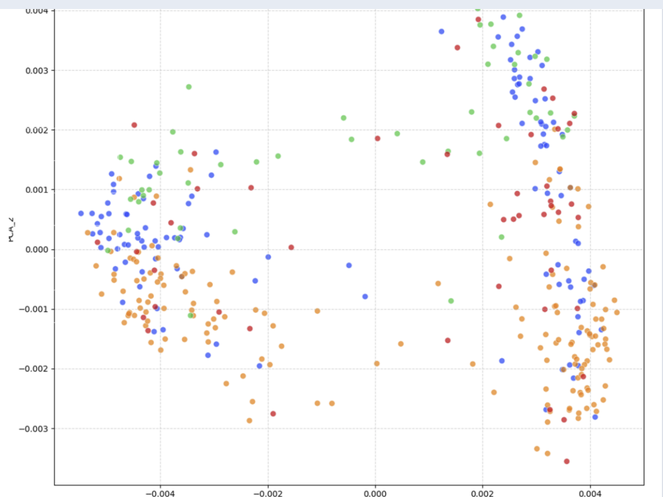
Confidence intervals from 1000-fold bootstrap resampling. Per-class F1 was not computed for the linear probe. Melanoma interval is wide owing to the smaller class size (n=41).

Panel C: Non-Linear Probing (UMAP)




| Class | F1-Score |
|---|---|
| hemorrhage | 0.79 |
| melanocytic_activation | 0.65 |
| melanome | 0.57 |
| nevi | 0.62 |
| **Total (Accuracy)** | **0.71** |

Panel D: Linear Probing (PCA)




| | |
|---|---|
| **Total (Accuracy)** | **~0.43** |

RESULTS

## Structure Needs Non-Linear Decoding

Zero-shot t-SNE revealed promising class clustering, indicating diagnostically relevant structure within the embedding space. Linear probing yielded an accuracy of only 0.43, confirming that representations are not linearly separable for nail lesion subclasses. Non-linear probing (k-NN) substantially outperformed, reaching an accuracy of 0.71 (95% CI 0.64–0.78) and a macro F1 of 0.66 (95% CI 0.59–0.72), with class-specific F1-scores of 0.79 for hemorrhage, 0.65 for melanocytic activation, 0.62 for nevi, and 0.57 for melanoma. Diagnostically meaningful information is encoded within the embedding space but requires non-linear decoding to be exploited.

CONCLUSION

## A Computationally Efficient Path to Adaptation

PanDerm encodes transferable dermatological representations that generalise to the specialised domain of nail unit pigmentations. The gap between linear and non-linear probing shows that the embedding manifold for nail lesions is geometrically complex, yet unlockable without full fine-tuning. This is a computationally efficient paradigm for adapting foundation models to niche dermatological diagnostic tasks.

Harald Kittler on LinkedIn

Sebastian Hochreiter on LinkedIn