Advancing Equity in Health AI: Improving Dermatological Image Datasets for Fair and Inclusive Healthcare Solutions

Published in **Nature Scientific Data (2025)**

Kumar Abhishek

Aditi Jain

Ghassan Hamarneh

2025 CS Diversity Award Presentation Day

⚠️ Content Warning ⚠️

Contains clinical images of **skin conditions** that some viewers may find sensitive.

AI for Skin Disease Diagnosis

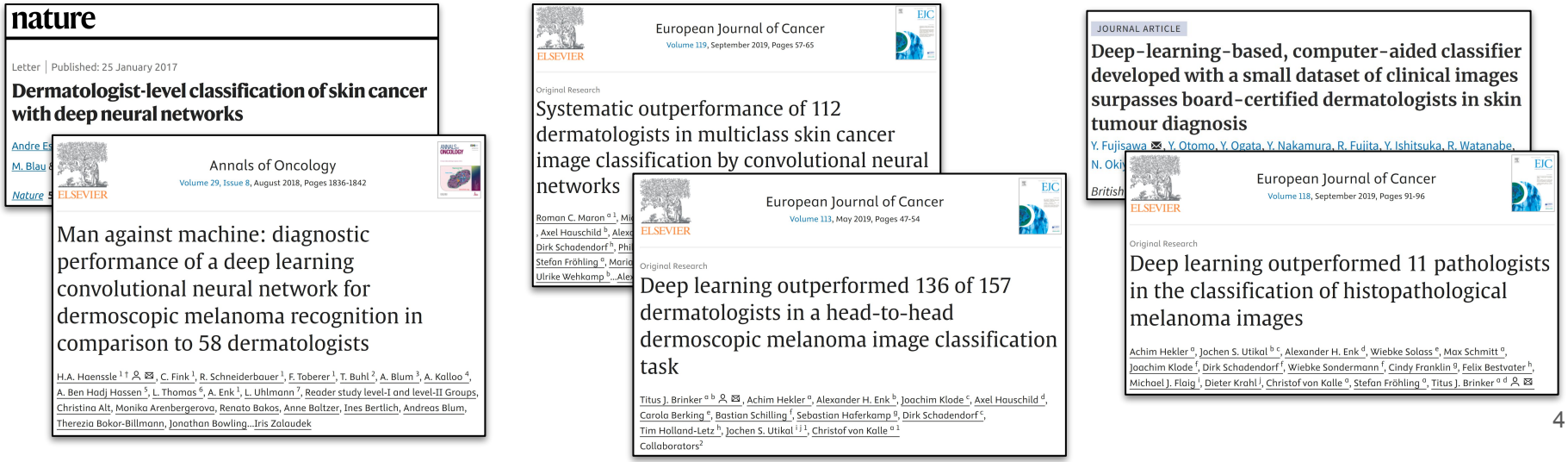
In studied populations, skin diseases are the **most common reason** for GP visits[1].

4th leading cause of non-fatal morbidity worldwide[2], yet ~**3 billion people lack access** to dermatological care[3].

AI for Skin Disease Diagnosis

In studied populations, skin diseases are the **most common reason** for GP visits[1].

4th leading cause of non-fatal morbidity worldwide[2], yet ~**3 billion people lack access** to dermatological care[3].



Variability in Skin Disease Appearance Affects Diagnosis

- Skin conditions may **appear different** across different skin tones.

Kawasaki Disease[5]

Erythema Annulare Centrifugum[6]

Variability in Skin Disease Appearance Affects Diagnosis

- Skin conditions may **appear different** across different skin tones.
- Doctors and AI perform poorly on darker-skinned patients.
  - 31%-61% **melanoma misdiagnosis on dark skin**, compared to 7%-13% on light skin[3].
  - "*state-of-the-art dermatology AI models exhibit substantial limitations … particularly on dark skin tones and uncommon diseases*"[4].

Kawasaki Disease[5]

Erythema Annulare Centrifugum[6]

Variability in Skin Disease Appearance Affects Diagnosis

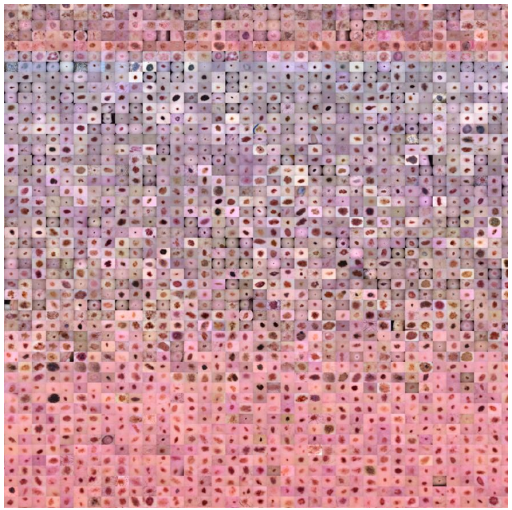
- Skin conditions may **appear different** across different skin tones.
- Doctors and AI perform poorly on darker-skinned patients.
  - 31%-61% **melanoma misdiagnosis on dark skin**, compared to 7%-13% on light skin[3].
  - "*state-of-the-art dermatology AI models exhibit substantial limitations … particularly on dark skin tones and uncommon diseases*"[4].
- Errors in datasets ⟹ models ⟹ healthcare.

Kawasaki Disease[5]

Erythema Annulare Centrifugum[6]

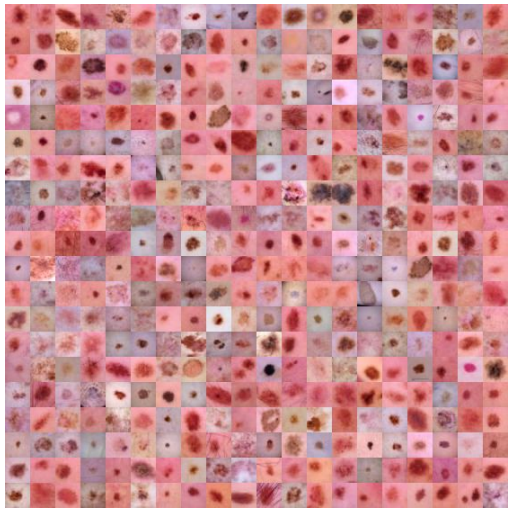
3 Widely Used Skin Image Datasets

HAM10000



~3500 citations

DermaMNIST

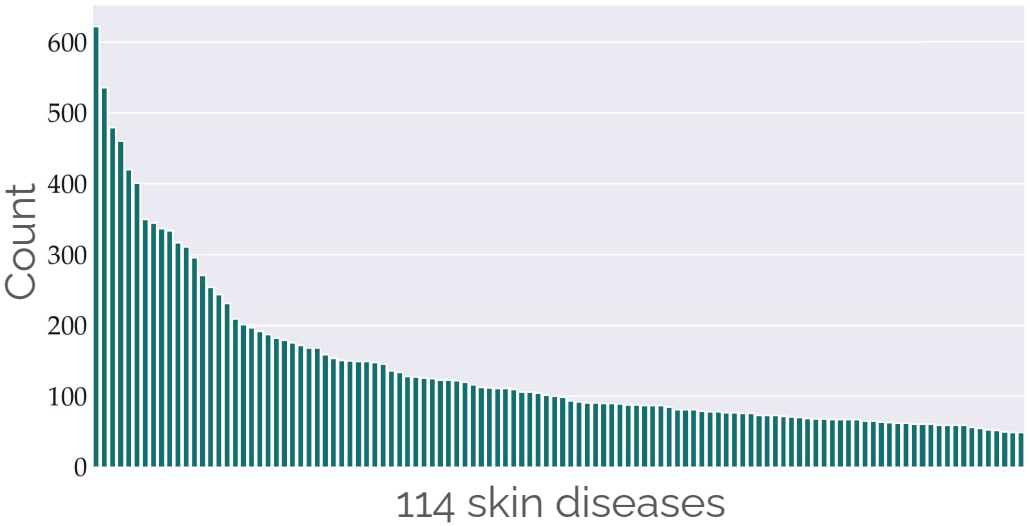


~1200 citations

Fitzpatrick17k

~250 citations

Underrepresented Diseases and Skin Tones



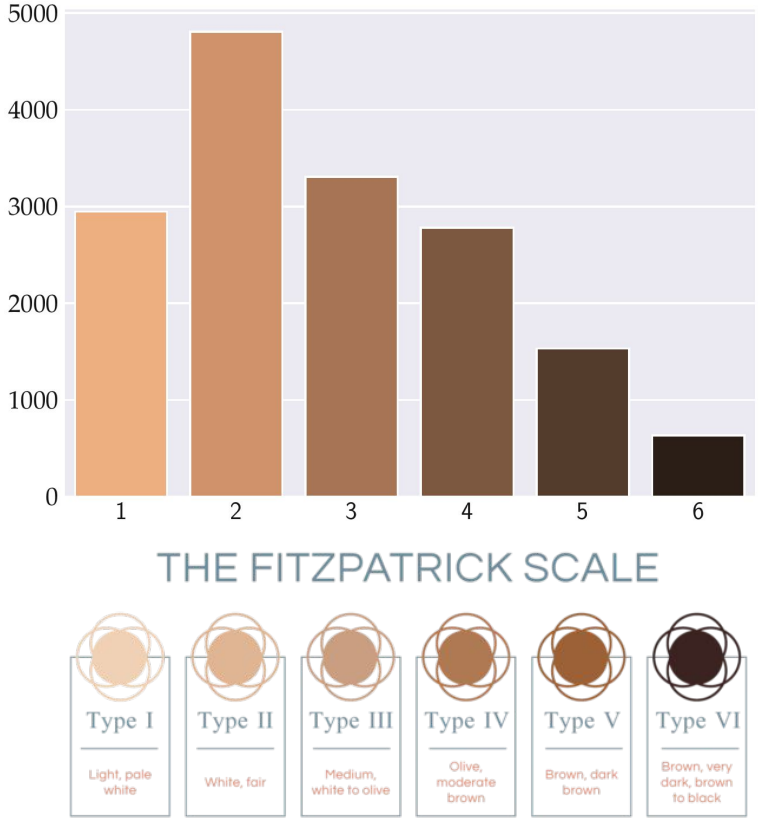
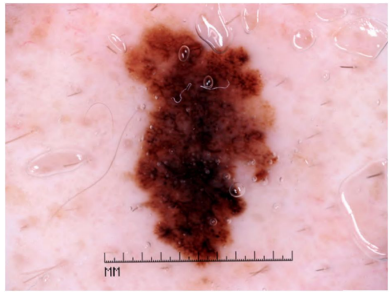
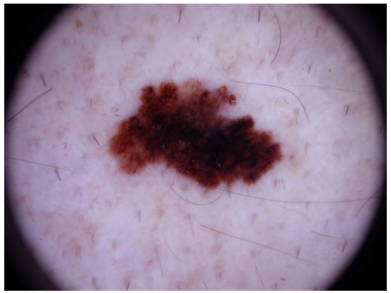
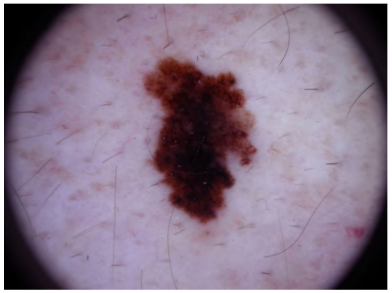


Image courtesy: [7, 8]

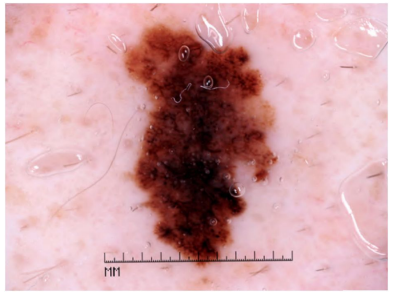
Metadata-based Analysis



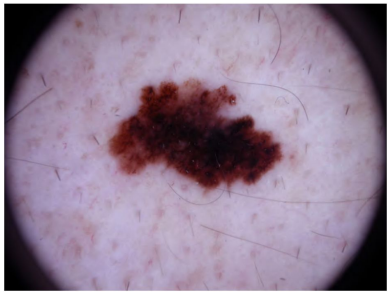




Metadata-based Analysis



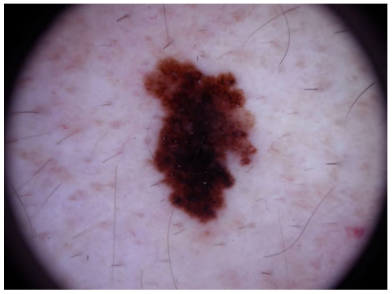
HAM_0007343



HAM_0007343

HAM_0002364

HAM_0002364

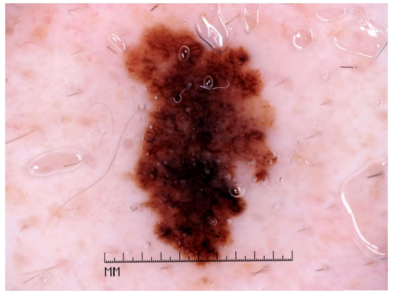


HAM_0007343

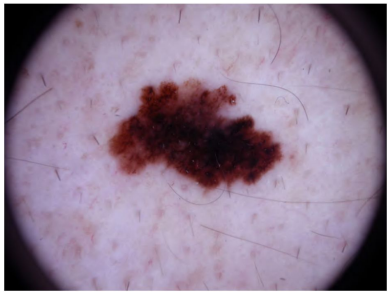
HAM_0002364

HAM_0002364

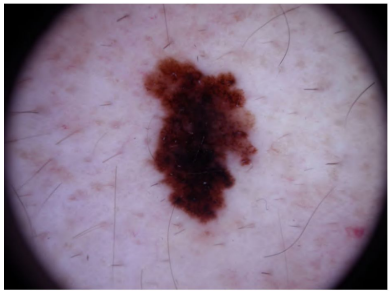
Metadata-based Analysis



HAM_0007343



HAM_0007343



HAM_0007343

HAM_0002364

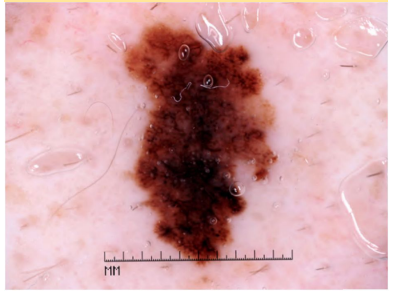
HAM_0002364

HAM_0002364

HAM_0002364

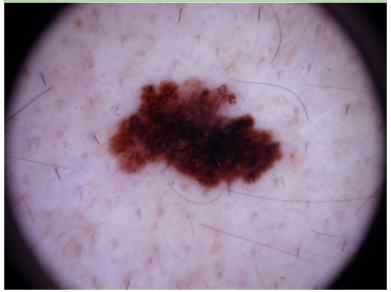
Duplicate Images Cause Data Leakage

validation image



HAM_0007343

training image



HAM_0007343

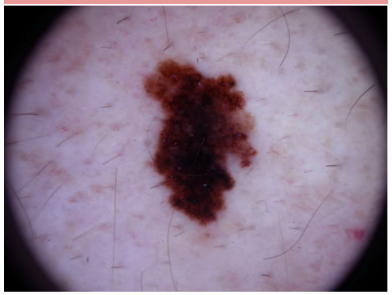
testing image

HAM_0002364

validation image

HAM_0002364

testing image



HAM_0007343

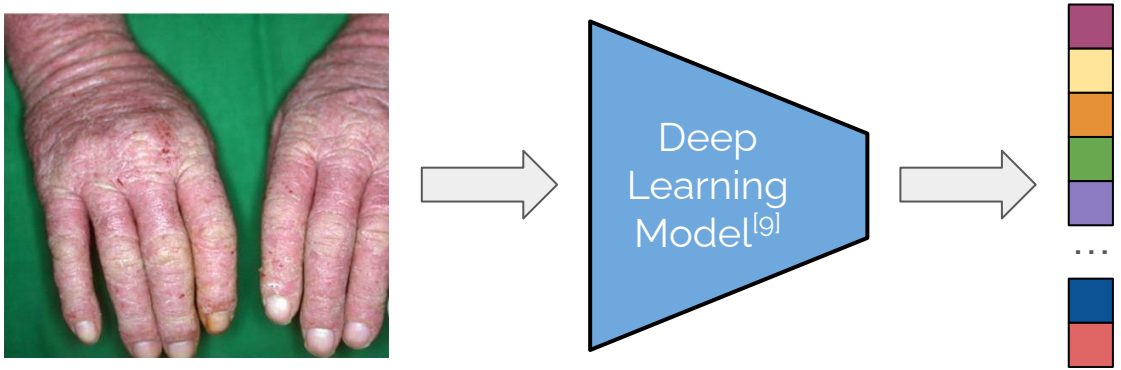
training image

HAM_0002364

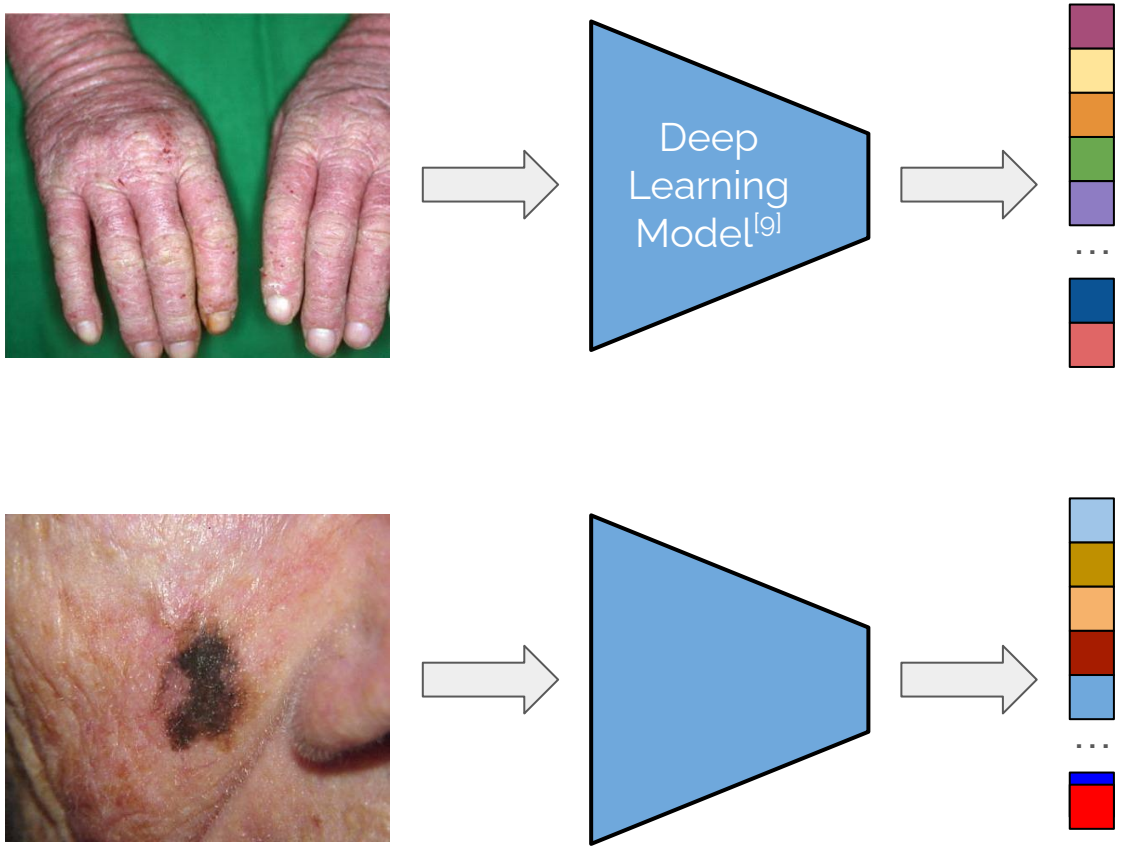
training image

HAM_0002364

Content-based Analysis: Image Embeddings



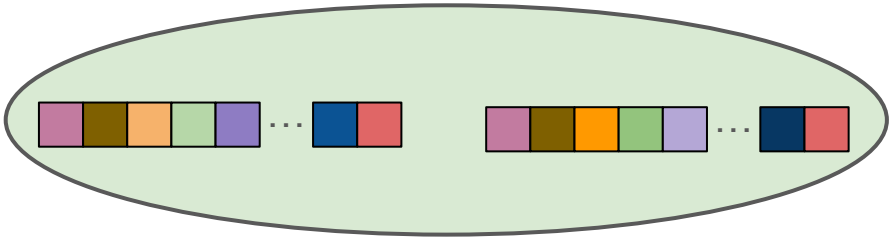
Content-based Analysis: Image Embeddings



Calculate embeddings for all the images

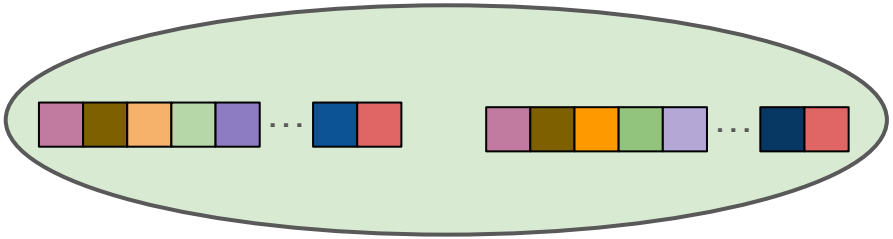
Detecting Duplicate Pairs

Detecting Duplicate Pairs



Pairwise embedding similarity

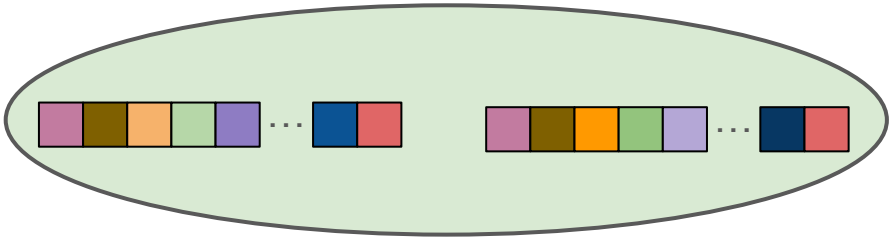
Detecting Duplicate Pairs



Pairwise embedding similarity

Different lighting but the same lesion

Detecting Duplicate Pairs



Pairwise embedding similarity

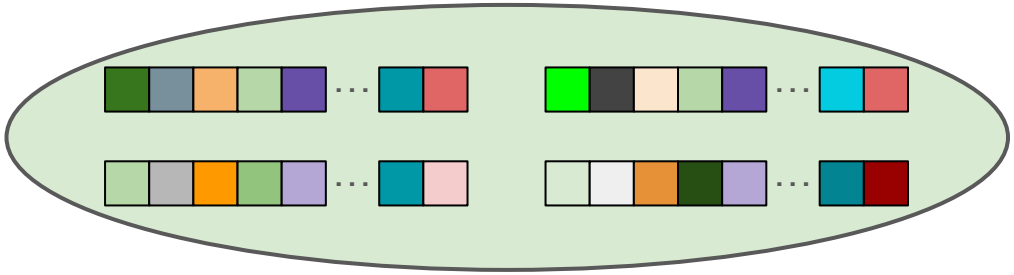
Different lighting but the same lesion

Different crops/zooms

Mirrored images

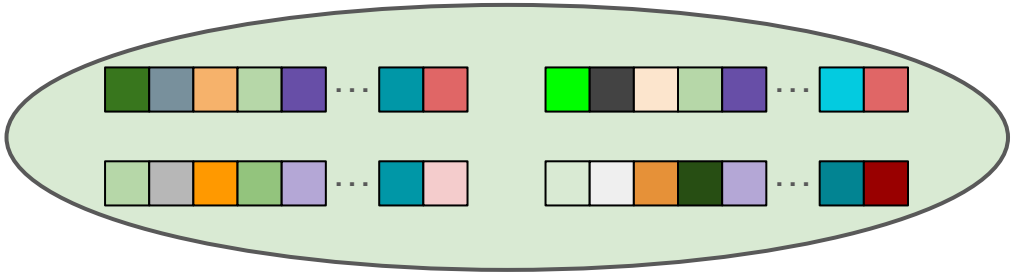
Different lighting + crop

Detecting Duplicate Clusters



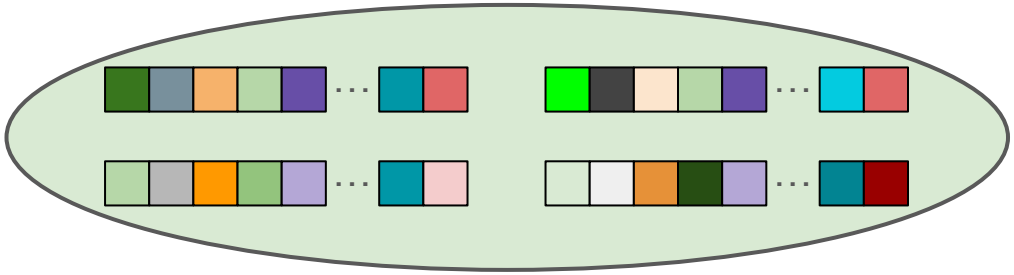
Cluster embeddings based on similarity

Detecting Duplicate Clusters



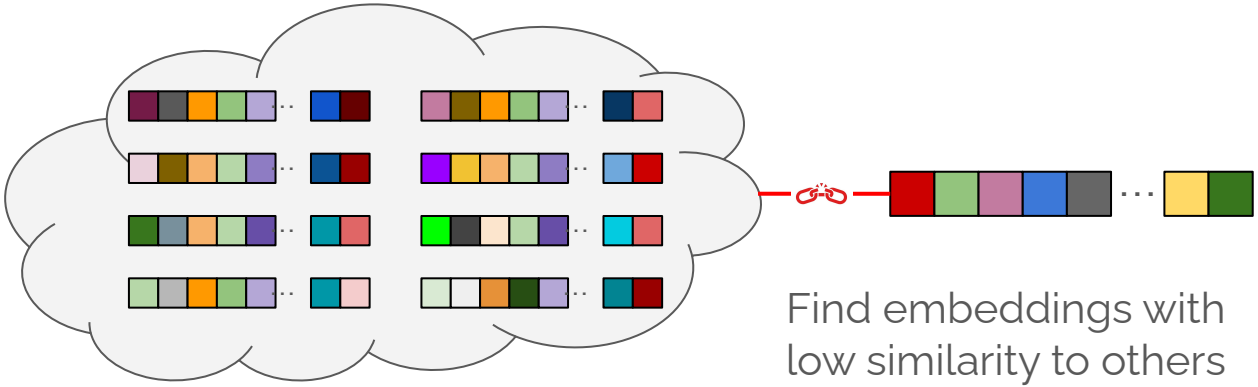
Cluster embeddings based on similarity

Detecting Duplicate Clusters



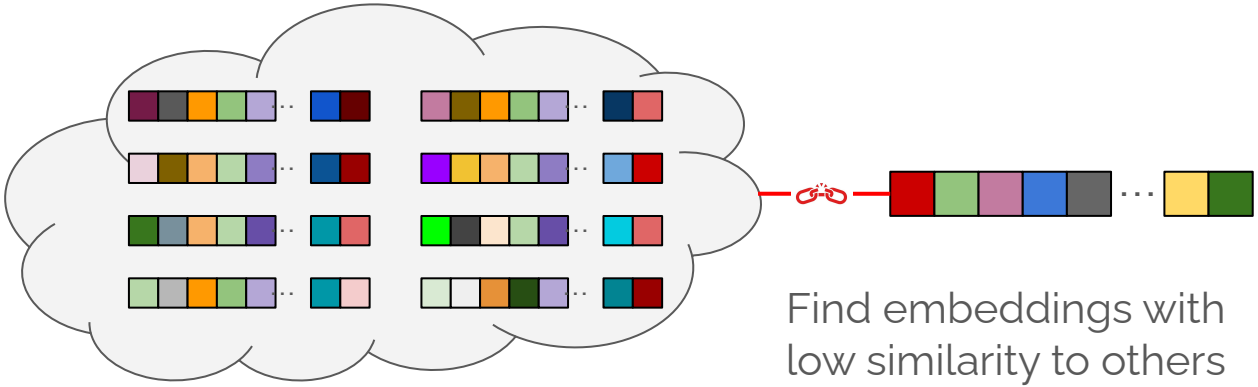
Cluster embeddings based on similarity

Discovering Outliers

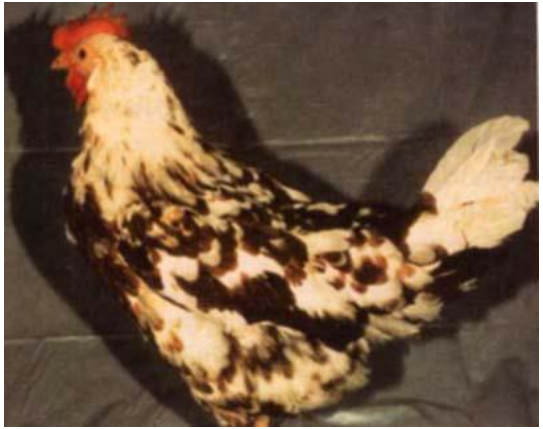


Find embeddings with
low similarity to others

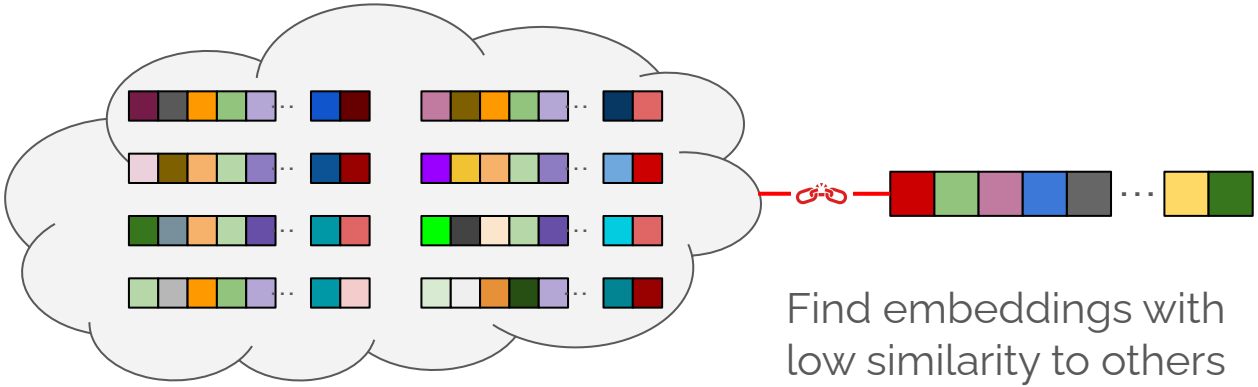
Discovering Outliers



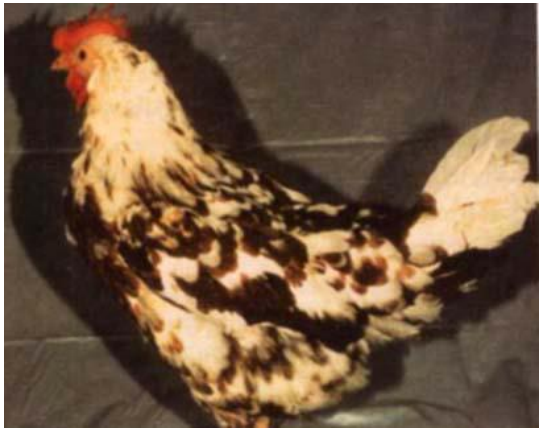
Find embeddings with low similarity to others

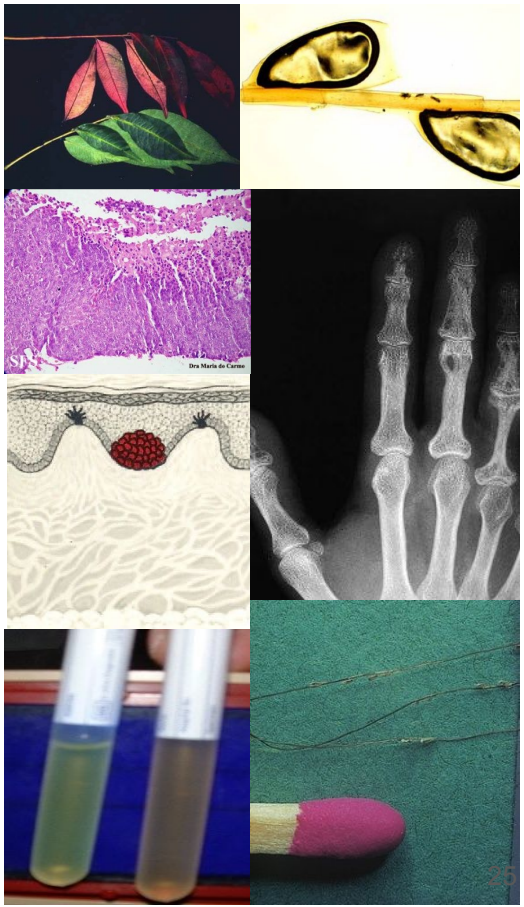


Discovering Outliers



Find embeddings with low similarity to others





Label Errors Impact Equity & Inclusivity

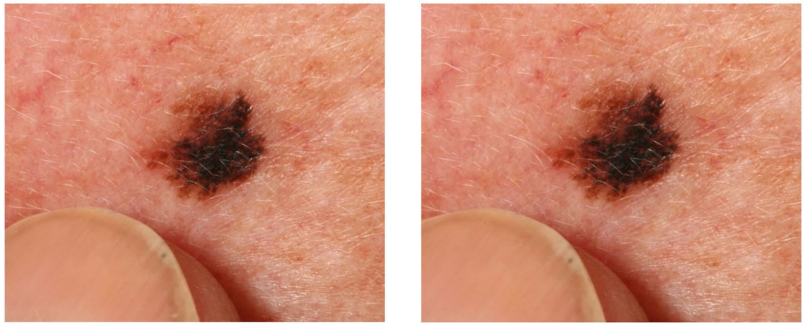
FST: 4 ≠ FST: 1

FST: 4 ≠ FST: 1

Image courtesy: [10]

Label Errors Impact Equity & Inclusivity

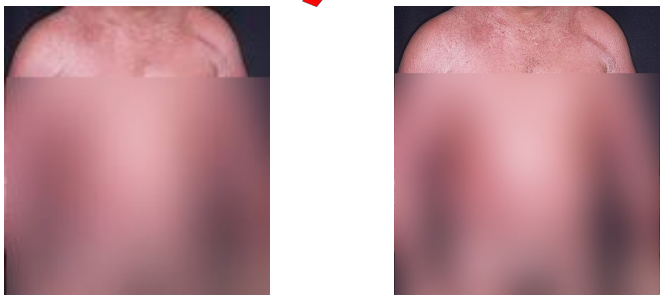
FST: 4 ≠ FST: 1



FST: 4 ≠ FST: 1

pustular psoriasis ≠ psoriasis

FST: 4 ≠ FST: 1



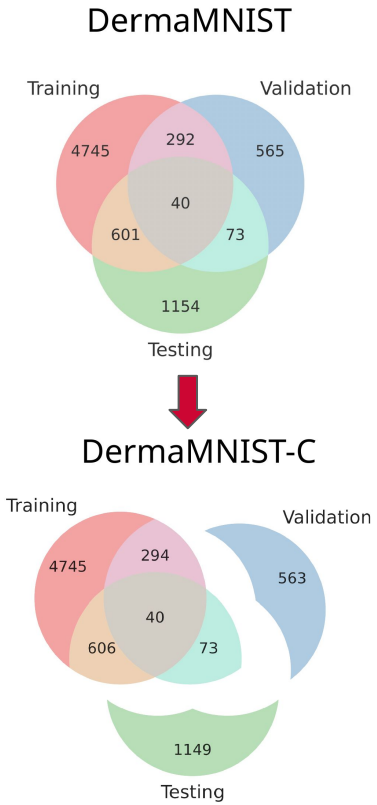
eczema ≠ allergic contact dermatitis

FST: 3 ≠ FST: 1

Image courtesy: [10]

Fixing Dataset Issues

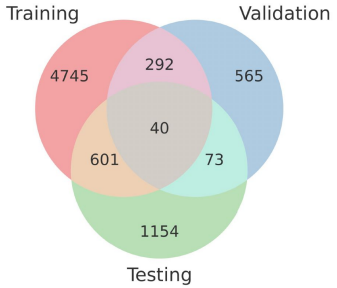
Clean data partitioning



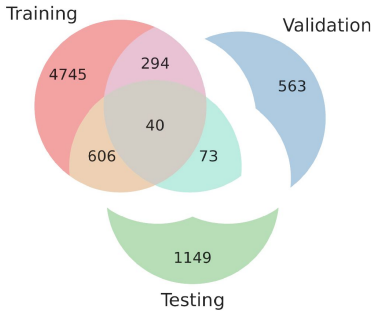
Fixing Dataset Issues

Clean data partitioning

DermaMNIST



DermaMNIST-C



Removing duplicates and outliers

Detect all duplicates.

If any label conflicts, remove all. Else, keep one.

Remove outlier images.

Disjoint train-valid-test sets.

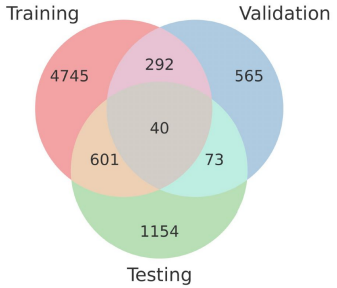
#images

16577 –> 11394

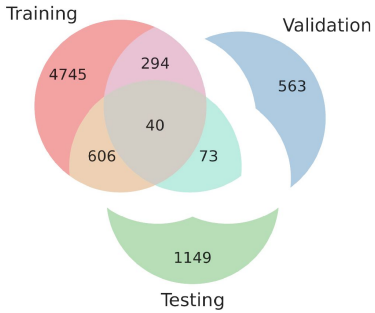
Fixing Dataset Issues

Clean data partitioning

DermaMNIST



DermaMNIST-C



Removing duplicates and outliers

Detect all duplicates.

If any label conflicts, remove all. Else, keep one.

Remove outlier images.

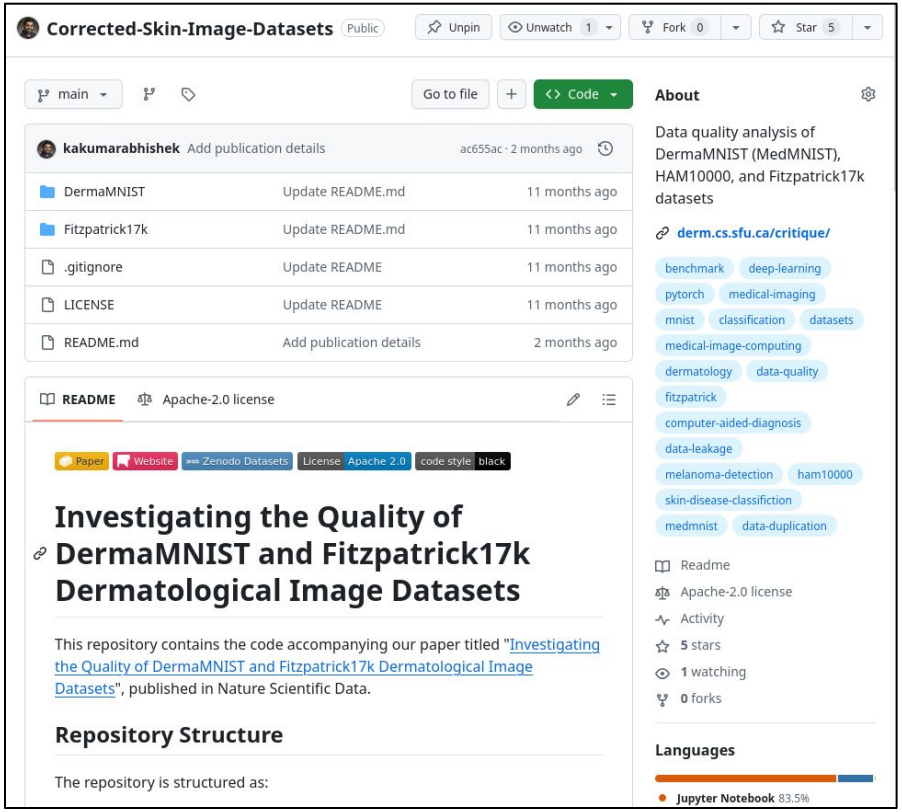
Disjoint train-valid-test sets.

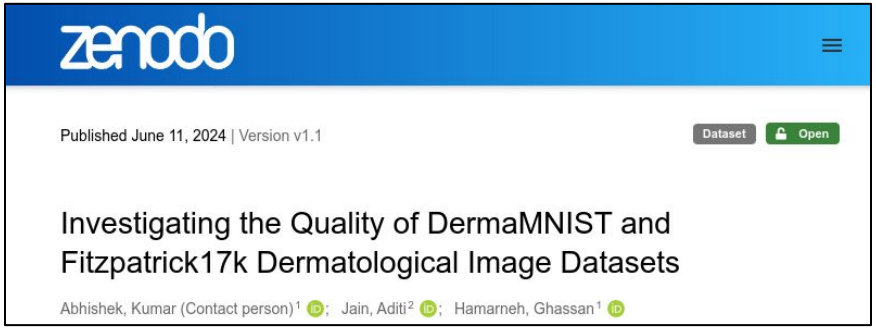
#images

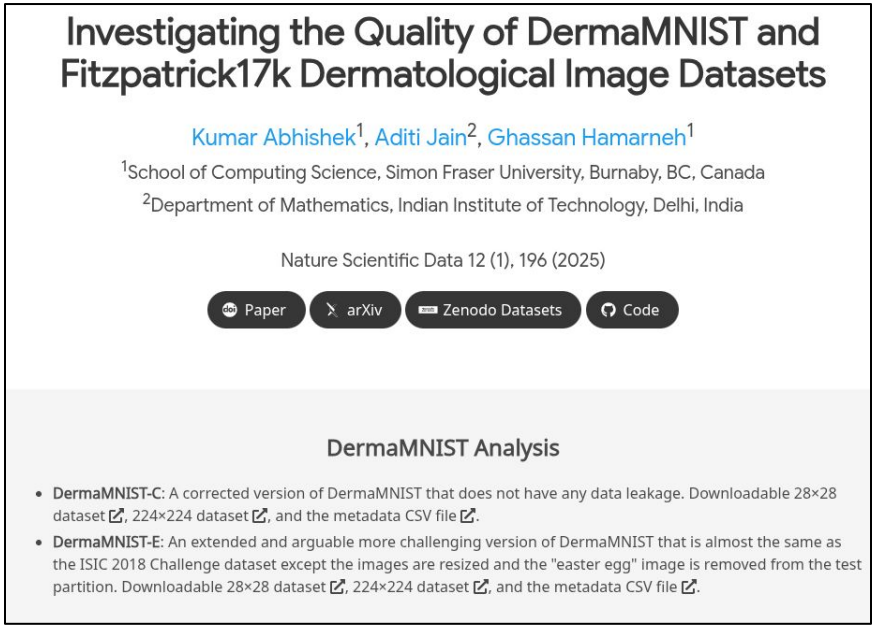
16577 –> 11394

New benchmarks for future research.

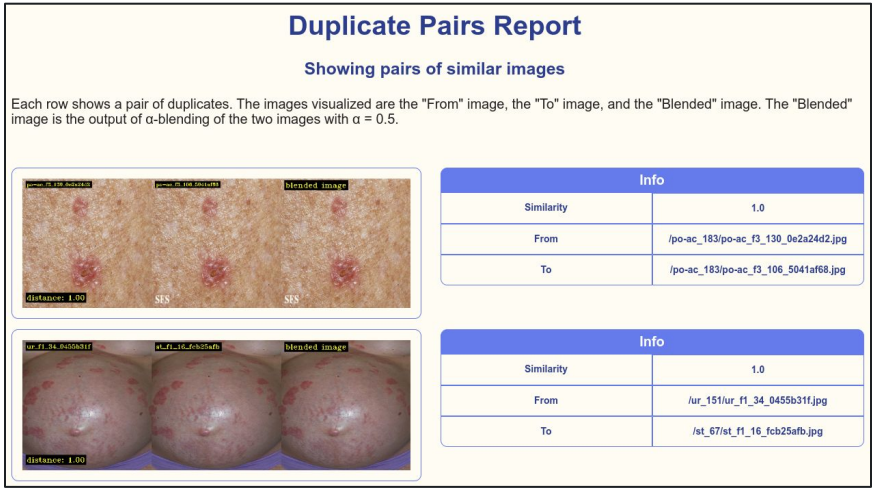
Analysis Pipeline is Public







Data Analysis Reports: https://derm.cs.sfu.ca/critique



Duplicate Pairs Report

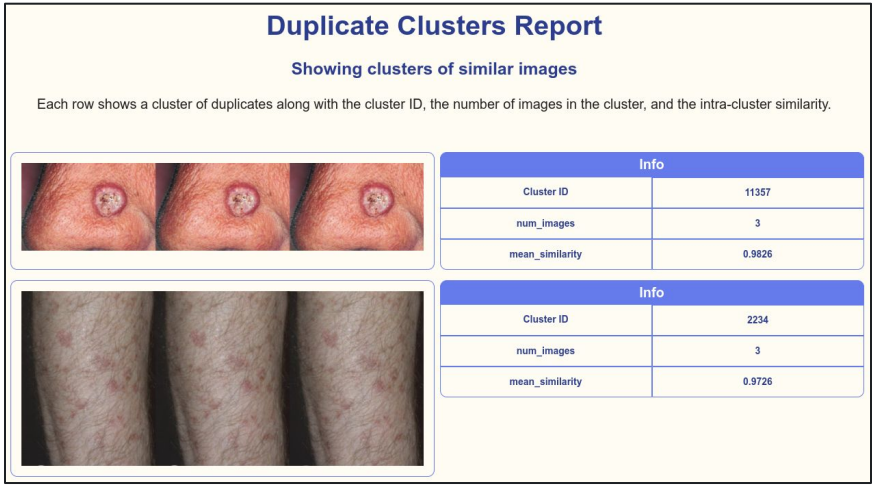
Showing pairs of similar images

Each row shows a pair of duplicates. The images visualized are the "From" image, the "To" image, and the "Blended" image. The "Blended" image is the output of α-blending of the two images with α = 0.5.

Info	
Similarity	1.0
From	/po-ac_183/po-ac_f3_130_0e2a24d2.jpg
To	/po-ac_183/po-ac_f3_106_5041af68.jpg

Info	
Similarity	1.0
From	/ur_151/ur_f1_34_0455b31f.jpg
To	/st_67/st_f1_16_fcb25afb.jpg

https://derm.cs.sfu.ca/critique/Fitzpatrick17k/duplicate_pairs.html



Duplicate Clusters Report

Showing clusters of similar images

Each row shows a cluster of duplicates along with the cluster ID, the number of images in the cluster, and the intra-cluster similarity.

Info	
Cluster ID	11357
num_images	3
mean_similarity	0.9826

Info	
Cluster ID	2234
num_images	3
mean_similarity	0.9726

https://derm.cs.sfu.ca/critique/Fitzpatrick17k/duplicate_clusters.html

Thank you!

kabhishe@sfu.ca

References

1. Schofield et al., " Skin conditions are the commonest new reason people present to general practitioners in England and Wales", *British Journal of Dermatology*, 2011.
2. Seth et al., "Global Burden of Skin Disease: Inequities and Innovations", *Current Dermatology Reports*, 2017.
3. Lyman et al., "A dermatological questionnaire for general practitioners in England with a focus on melanoma; misdiagnosis in black patients compared to white patients", *Journal of the European Academy of Dermatology and Venereology*, 2016.
4. Daneshjou et al., "Disparities in dermatology AI performance on a diverse, curated clinical image set", *Science Advances*, 2022.
5. Black & Brown Skin, https://www.blackandbrownskin.co.uk/further-resources.
6. DermNet, https://dermnetnz.org/.
7. Pakzad et al., "CIRCLe: Color Invariant Representation Learning for Unbiased Classification of Skin Lesions", *European Conference on Computer Vision (ECCV) ISIC Skin Image Analysis Workshop*, 2022.
8. Fitzpatrick Skin Type Chart, https://www.tribecamedspa.com/fitzpatrick-skin-type-chart/.
9. fastdup, https://github.com/visual-layer/fastdup.
10. What's Your Type?, https://suttonderm.com/blog/whats-your-type/.