DermaDiagnosis: A Smartphone Interface for Efficiently Diagnosing Malignant & Non-malignant Melanoma in Clinical and Non-Clinical Settings

Anurag Gottipati, Academies of Loudoun & Rock Ridge High School
Email: anurag.gottipati@gmail.com, Phone Number: 703-297-2448

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BACKGROUND

- Melanoma is the deadliest form of skin cancer and survival rates drop significantly after metastasis. Despite increasing awareness of malignant melanoma's dangers over the last few decades, clinical diagnostic measures for melanoma are still highly inaccurate.
- Melanoma misdiagnosis accounts for more pathology and dermatology malpractice claims than any cancer but breast cancer due to the fatality of early misdiagnosis in significantly reducing a patient's chances of survival.
- One of the greatest barriers to accurate melanoma diagnosis is melanoma's manifestation as colored lesions. Malignant melanoma can mistakenly appear as benign lesions (false negatives) and similarly benign pigmented lesions can clinically simulate malignant melanoma (false positives).
- Though proper histologic examination of pigmented lesions is vital to ensuring proper diagnosis and treatment, often dermatologists have to sample multiple biopsies (5 - 10) for pathological analysis further meriting the importance of non-invasive diagnostic measures for melanoma early on.

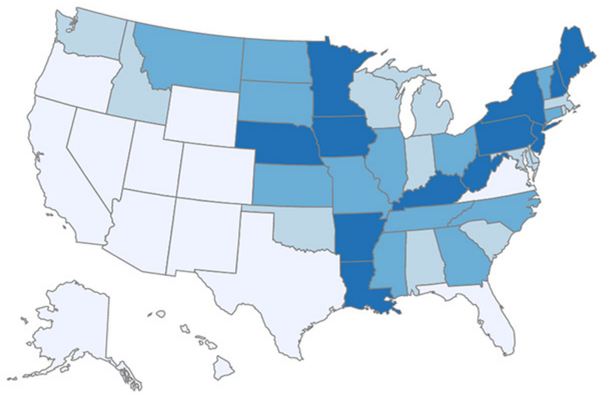

Figure 1. Compiled by the CDC , this infographic is representative of 2018 melanoma incidence rates by state across the USA (all ages, races, ethnicities, and sexes were included in the sampling).

OBJECTIVE

1. To recognize the capacity of machine learning in medical settings by improving clinical outcomes and more specifically enhance the accuracy of melanoma diagnostic systems facilitating early detection as well through accessibility.

MATERIALS & METHODS

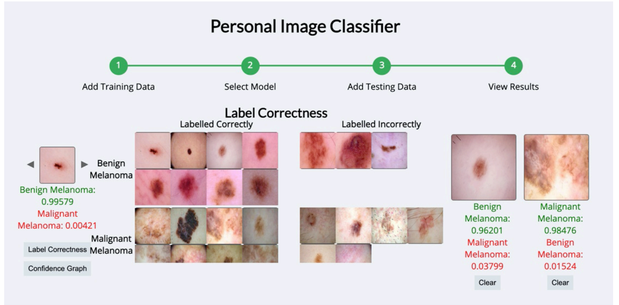

Figure 2. A cross section of the algorithm displays how the program is able to differentiate between malignancy and benignness to the accuracy of 5 decimal points.

1. Melanoma images for training the machine learning model were accessed from the publicly available Kaggle dataset named, "Skin Cancer: Malignant vs Benign," and is credited to Claudio Fanconi (https://www.kaggle.com/fanconic/skin-cancer-malignant-vs-benign). In this dataset the model was trained on 1440 benign and 1197 malignant melanoma images and was tested with 360 benign and 300 malignant melanoma images.
2. MIT App Inventor's "Personal Image Classifier" program (https://classifier.appinventor.mit.edu/oldpic/) - normally intended to differentiate between facial expressions - was modified with different parameters for pigmented lesion analysis and identification of malignancy. Two categories respectively titled "Benign Melanoma" and "Malignant Melanoma" were created. The 1440 benign pigmented lesions were manually deposited into the "Benign Melanoma" category as was done for the malignant melanoma images to train the machine learning algorithm with a sufficient amount of data.
3. Using the parameters shown and explained in Figure 3., the model was then trained and tested by manually depositing 360 benign melanoma images into the "Benign Melanoma" category and 300 malignant melanoma images into the "Malignant Melanoma" category.
4. Once the model was developed and tested, it was downloaded as an "aia" file and the following methodology outlined by MIT App Inventor was followed to translate the algorithm model into a functioning smartphone, Android application - https://drive.google.com/file/d/1NwYALy5vILNR_38jnYdbMQBX4aJzppKy/view.

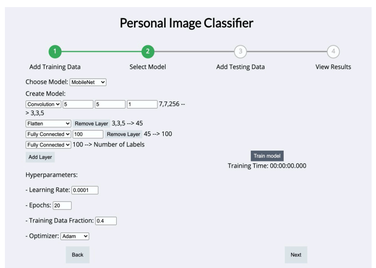

Figure 3. A deep learning convolutional neural network (CNN) with three 3x5 filters using the Adam optimizer (efficiently processes large datasets with noisy gradients) was developed. Model robustness was enhanced by using 20 epochs and a 75% training data fraction.

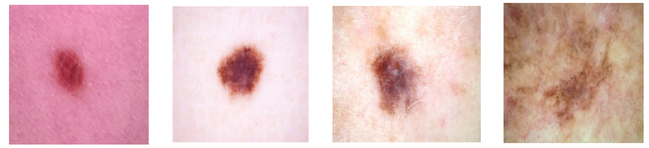

Figure 4. Sample pigmented lesion (melanoma) images used

RESULTS

Table 1. Observed chances of Malignancy or Benignness as detected by DermaDiagnosis when tested with 360 **Benign Melanoma images**.

Group	χ	σ	N	SE Mean	df	95% CI	t
Benign	.9301421	.1117578	360	.0059	718	(0.844, 0.8766)	103.6487
Malignant	.0698579	.1117578	360	. 0059	718	(0.844, 0.8766)	103.6487

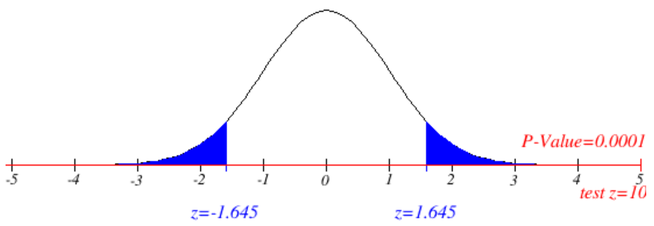

Figure 5. Two tailed t-test comparing the chances of a pigmented lesion manifesting as benign or malignant melanoma as detected by the *DermaDiagnosis* system revealed a significant difference between both groups ($p < 0.0001$). A significant difference indicates that the system's efficacy in detecting melanoma and differentiating between malignancy and benignness can't solely be associated with chance but can be explained by the underlying convolutional network's ability to process and compute histologic differences

Table 2. Observed chances of Malignancy or Benignness as detected by DermaDiagnosis when tested with 360 **Benign Melanoma images**.

Group	χ	σ	N	SE Mean	df	95% CI	t
Benign	.1653778	.2214866	360	.0117	718	(-0.7016, -0.6368)	-40.5366
Malignant	.8346221	.2214866	360	.0117	718	(-0.7016, -0.6368)	-40.5366

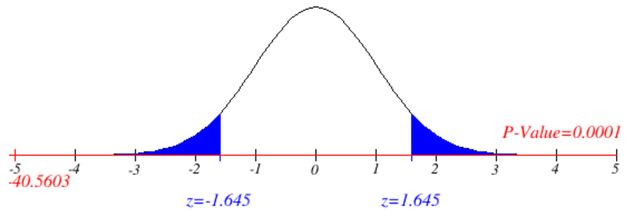

Figure 6. For the classification of benign pigmented lesions as well, a two tailed t-test revealed *DermaDiagnosis* was able to significantly differentiate between chances of malignancy and benignness ($p < 0.0001$).

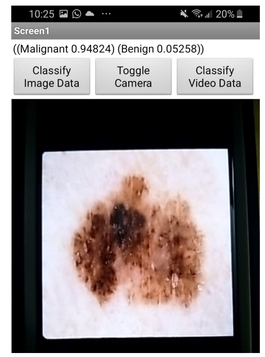

Figure 7. The *DermaDiagnosis* app offers it users the ability to classify pigmented lesions as melanomas with preexisting images on the smartphone or through its "Classify Video Data" option. The app doesn't provide clinical or medical advice.

DISCUSSION

- To my knowledge, this is the first study that utilizes a preexisting machine learning framework for medical applications and sets a precedent for more possible medical technology innovations in the future. My current findings are suggestive of *DermaDiagnosis* being able to diagnose benign melanomas with an accuracy rate of 93% and malignant melanomas accurately around 84% of the time.
- Clinical trials and further feedback from experts in the field of Dermatology can augment the current form of the app and offer more diverse manifestations of melanoma for increasing the app's precision in early detection across different stages.

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