Diagnostic typing of skin lesion images using k-nearest neighbor

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Background and Introduction

Every year over 3.5 million people are diagnosed with skin cancer in the United States [1] . Early detection and diagnosis of a malignant skin lesion allows physicians to save the patient's life with a rate of cure being over 90% [2]. Recent studies suggest that machine learning approaches can aid in diagnosing skin lesions in less time and with more accuracy than a board-certified dermatologist. The objective of this research is to evaluate the performance of the k-nearest neighbor (kNN) algorithm on skin lesion typing. However, kNN accuracy was poor compared to accuracies from expert dermatologists and from an analysis using a convolutional neural network (CNN) on the same data set.

Methodology

The kNN algorithm was evaluated on 10,000 publicly available skin lesion images, known as the HAM10000 data set [3]. A file containing the RGB values of the 8x8 images was imported into RStudio and images were split into seven groups based on type of skin lesion. Each of the seven groups are split into training and testing data, with 60% of each type randomly selected for training and the remaining 40% used for testing. kNN was used for classification with k = 3 and k = 5 neighbors. Additionally, the training data was filtered because the largest group was expected to bias the results. kNN was evaluated using all the training data; and all data excluding either (1) the largest category, (2) the two smallest categories, and (3) 80% of the largest category. Classification accuracies for kNN were compared to results obtained from CNNs and dermatologists.

Availability: https://github.com/DaniSenechal/KNNSkinLesions

	AKIEC	BCC	BKL	DTF	NV	VASC	MEL	Totals
Train	196	308	659	69	4023	85	667	6007
Test	131	206	440	46	2682	57	446	4008
Totals	327	514	1099	115	6705	142	1113	10015

Table 1. Number of images per legion type. Abbreviations: AKIEC, actinic keratoses; BCC, basal cell carcinoma; BKL, benign keratosis-like lesions; DTF, dermatofibroma; MEL, melanoma; NV, melanocytic nevi; VASC, vascular lesions

Results

k	Accuracy (%)	DTF	NV	VASC
3	46.05	✓	✓	✓
3	30.12	✓		✓
3	46.81		✓	
3	30.20	✓	20%	✓
5	46.21	✓	✓	✓
5	32.91	✓		✓
5	47.69		✓	
5	31.85	✓	20%	✓

Table 2. kNN accuracies for different training sets; either 20% of samples or all samples (checkmark) were included

	predictions						
test.category.vec	AKIEC	BCC	BKL	DTF	NV	VASC	MEL
AKIEC	13	29	40	2	39	1	7
BCC	19	56	47	5	66	7	6
BKL	6	30	155	6	200	2	41
DTF	6	7	11	1	19	0	2
NV	4	28	112	9	2433	5	91
VASC	0	4	4	0	42	4	3
MEL	14	17	63	5	276	1	70

Figure 1. The confusion matrix of the accuracies. The diagonal contains the number of samples in each category classified correctly.

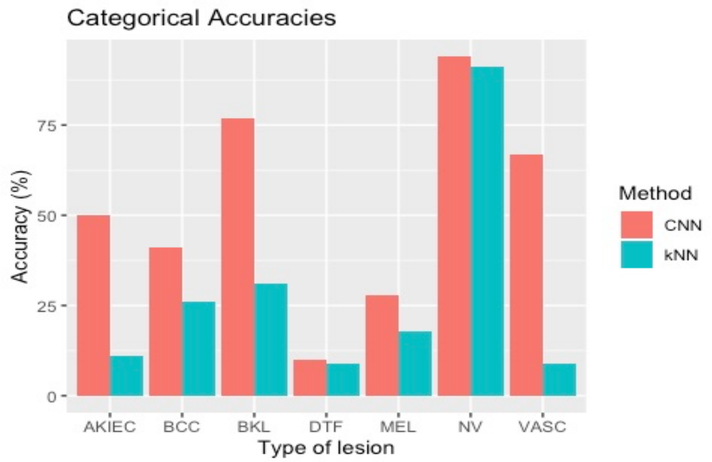

Figure 2. Classifier performance of kNN compared to CNN in each of the seven categories of skin lesions

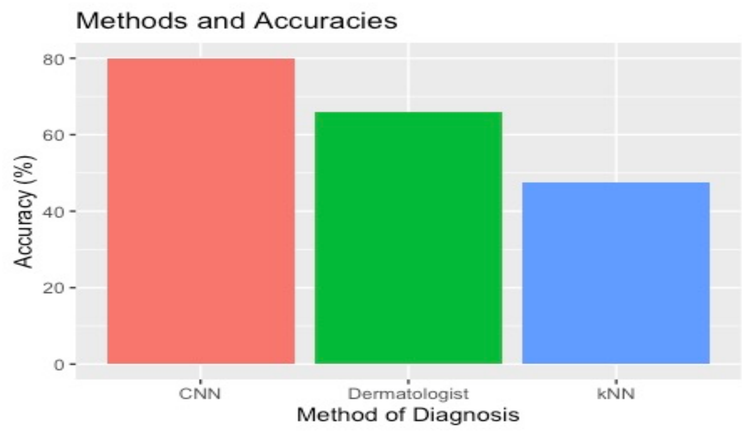

Figure 3. Classifier and dermatologist performance of averaged over all skin lesion types.

Conclusions:

Results from the kNN algorithm show that the method performs moderately with accuracies ranging from 30-47% . When comparing kNN to CNN, as well as a dermatologist's diagnosis, kNN is outperformed by the other two. As seen in **Fig. 3**, kNN is about 60% as accurate as CNN, and is about 20% less accurate than the dermatologists. A better comparison of performance, showing the higher accuracy of CNN, can be seen in **Fig. 2**, which shows the performance in each of the seven categories of skin lesions.

References

[1] M. Bayraktar, S. Kockara, T. Halic, M. Mete, H. K. Wong, and K. Iqbal, "Local edge-enhanced active contour for accurate skin lesion border detection," *BMC Bioinformatics*, vol. 20, pp. 1–11, Mar. 2019.
[2] K. M. Hosny, M. A. Kassem, and M. M. Foaud, "Classification of skin lesions using transfer learning and augmentation with Alex-net," *PLoS ONE*, vol. 14, no. 5, pp. 1–17, May 2019.
[3] https://www.kaggle.com/kmader/skin-cancer-mnist-ham10000

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