

# Automatic Detection and Classification of tick-borne skin lesions using Deep Learning

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## Summary

- **Motivation:** The incidence of tick-borne diseases, like Lyme disease, has drastically increased within the last decade [Wikel, 2018]. As a result, more efforts in improving lesion identification approaches and diagnostics for tick-borne illnesses is critical in preventing serious long-term complications [Rodriguez-Morales et al., 2018].
- **Approach:** In this paper, we propose a 3-class classification approach of detecting erythema migrans, mosquito bite(s), and healthy skin. Each model was trained using stochastic gradient descent, with a learning rate set from a range between  $(3 \times 10^{-5}, 3 \times 10^{-4})$ , where the learning rate was set to minimize the training loss, resulting in most cases to a learning rate close to  $10^{-3}$ . The optimizer is Adam with weight decay. Our study ran a convolutional neural network (CNN) architectures: ResNet 34, ResNet 50, VGG 19, and DenseNet 121
- **Contributions:** We propose an approach that results in a more diverse outcome of images in terms of skin color, textures, and skin features by expanding our image data search to include six other languages from geographies abroad that have prolific cases of tick-borne diseases.

## Overview of sample images by search query per language

Language	Tick Bite	Mosquito Bite	Healthy Skin	Total
English	320	240	320	880
Spanish	320	320	320	960
French	240	320	320	880
German	240	320	320	880
Portuguese	240	320	240	800
Mandarin	320	80	320	720
Russian	320	320	320	960
Total	2000	1920	2160	6080

## Overview of queries for Google Image search in seven selected languages

Language	Tick Bite Query	Mosquito Bite Query	Healthy Skin Query
English	Tick bite	Mosquito bite	Healthy skin
Spanish	Picadura de garrapata	Picadura de mosquito	Piel saludable
French	Morsure de tique	Piqûre de Moustique	Peau saine
German	Zeckenbiss	Mûckenstich	Gesunde haut
Portuguese	Mordida de carrapato	Picada de mosquito	Pele saudável
Mandarin	蜱咬	蚊虫叮咬	健康的皮肤
Russian	укус клеща	комариный укус	здоровая кожа
ukus kleshcha	komarinny ukus	zdorovaya kozha	

## Classification Results over multiple neural network architectures

- The key performance metric in the study was accuracy in demonstrating the number of predictions our model correctly identified as a tick bite, mosquito bite or healthy skin. Our model obtained the best accuracy of 80.72% trained on the DenseNet 121 architecture.

Model	Training Loss	Validation Loss	Validation Accuracy
ResNet-34	0.400625	0.702235	79.16%
ResNet-50	0.749036	1.147042	53.12%
VGG-19	0.452295	0.519739	78.64%
DenseNet-121	0.339066	0.568043	80.72%

## Results of search queries run on VGG 19 architecture



Results of search queries run on VGG 19 architecture in (a) English, (b) Spanish, (c) French, (d) German (e) Mandarin (f) Portuguese and (g) Russian.

## Conclusion & Future Work

- Our search queries did indeed present more diverse image data
- Future work will consider classical and ensemble approaches including an SVM, Inceptionv4, MobileNet, and EfficientNet and adding image data from geographies like Africa, India, and Middle East

## References

Alfonso J Rodriguez-Morales et al., Epidemiology of zoonotic tick-borne diseases in latin america: Are we just seeing the tip of the iceberg? F1000Research, 7, 2018.  
Stephen K Wikel. Ticks and tick-borne infections: complex ecology, agents, and host interactions. *Veterinary sciences*, 5(2):60, 2018.