Conditional dependence tests reveal the usage of ABCD rule features and bias variables in automatic skin lesion classification

Christian Reimers, Niklas Penzel, Paul Bodesheim, Jakob Runge, Joachim Denzler
Motivation
Deep Learning is the State of the Art

[4]: Tschandl et al.: “Comparison of the accuracy of human readers versus machine-learning algorithms for pigmented skin lesion classification: an open, web-based, international, diagnostic study”
Deep Learning is the State of the Art

[4]: Tschandl et al.: “Comparison of the accuracy of human readers versus machine-learning algorithms for pigmented skin lesion classification: an open, web-based, international, diagnostic study”
Testing if a Feature is used
Testing if a Feature is used
Medically Relevant vs. Biases

1 https://dermoscopedia.org/ABCD_rule
Saliency Maps

**MAIN APPROACHES**
Saliency Maps

**Main Approaches**

- Gradient-based \( S = \frac{\partial F(I)}{\partial I} \)
Saliency Maps

Main Approaches

- Gradient-based \( S = \frac{\partial F(I)}{\partial I} \)
- Ablation-based \( S = F(I) - F(I \backslash (x,y)) \)
Saliency Maps

**Main Approaches**

- Gradient-based \( S = \frac{\partial F(i)}{\partial i} \)
- Ablation-based \( S = F(I) - F(I_{\setminus (x,y)}) \)
- Gradient and Value-based \( S = \frac{\partial F(i)}{\partial i} \odot l \)
Example: Asymmetry
Example: Asymmetry

Does the Network use the Asymmetry of the lesion?
Method
The Method of Conditional Dependence

The Method of Conditional Dependence

The Method of Conditional Dependence

The Method of Conditional Dependence

Classifiers: Perez et al.

Different **No. of Augmentations**, **Backbones**, **Aggregation method**

Twelve binary models for melanoma prediction and twelve binary models for seborrheic keratosis.

Classifiers: Gessert et al.

**ENSEMBLE OF EFFICIENT NETS**

- Multi-class Classifier
- Ensemble of pretrained CNNs
- Recognizes 8 Classes
- Test-time Augmentation

Classifiers: Gessert et al.

**ENSEMBLE OF EFFICIENTNETS**

- Multi-class Classifier
- Ensemble of pretrained CNNs
- Recognizes 8 Classes
- Test-time Augmentation

**CAUTION**

We did not train the full ensemble, but only five EfficientNet B0

Experimental Setup

\[ Y \perp \perp X | Y \Rightarrow \Rightarrow \Rightarrow /two.pnum/three.pnum/two.pnum/four.pnum \]

Reimers et al.
Understanding Classification
12 / 24
Experimental Setup

\[ Y \perp X | Y \]

\[ Y \perp X \]

\[ Y \Rightarrow \}

\[ \Rightarrow \]

\[ \Rightarrow /two.pnum\]

\[ /three.pnum / /two.pnum / /four.pnum \]
Experimental Setup
Experimental Setup
Experimental Setup

Reimers et al. Understanding Classification
Results
“Placebo” Features

Orientation
"Placebo" Features

Orientation

Rand. Symmetry
“Placebo” Features

Orientation  Rand. Symmetry  Image ID
“Placebo” Features

Orientation

Rand. Symmetry

Image ID

MNIST Class

Reimers et al. Understanding Classification
## “Placebo” Features – Results

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ABCD Rule Features

Asymmetry

https://dermoscopedia.org/ABCD_rule
ABCD Rule Features

Asymmetry  Border

\[2\text{https://dermoscopedia.org/ABCD_rule}\]
ABCD Rule Features

Asymmetry  Border  Color

https://dermoscopedia.org/ABCD_rule
ABCD Rule Features

Asymmetry

Border

Color

Derm. Structures

https://dermoscopedia.org/ABCD_rule
# ABCD Rule Features – Results

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- **< 25%**
- **25% - 75%**
- **> 75%**


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- < 25%<br>- 25% - 75%<br>- > 75%

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Bias Features

Age
Bias Features

Age  Sex
Bias Features

Age  
Sex  
Skin Color
Bias Features

Age  Sex  Skin Color  Colorful Patches
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### Bias Features – Results

![Bias Features Table]

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![Color Key]

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Legend:
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Skin Color Bias

![Skin Color Score Distribution](image)
Skin Color Bias

- Melanoma vs. Not Melanoma
- Seborrheic Keratosis vs. Not Seborrheic Keratosis

Bias in the ISIC 2017 challenge dataset
Summary

3https://dermoscopedia.org/ABCD_rule
Summary

X

(✓)

(✓)

3 https://dermoscopedia.org/ABCD_rule
Thank You!
References
References I


