Norwegian Centre for
Integrated Care and Telemedicine

NST

Requirements for Color in a Computer Aided Diagnostics Tool for Dermoscopy

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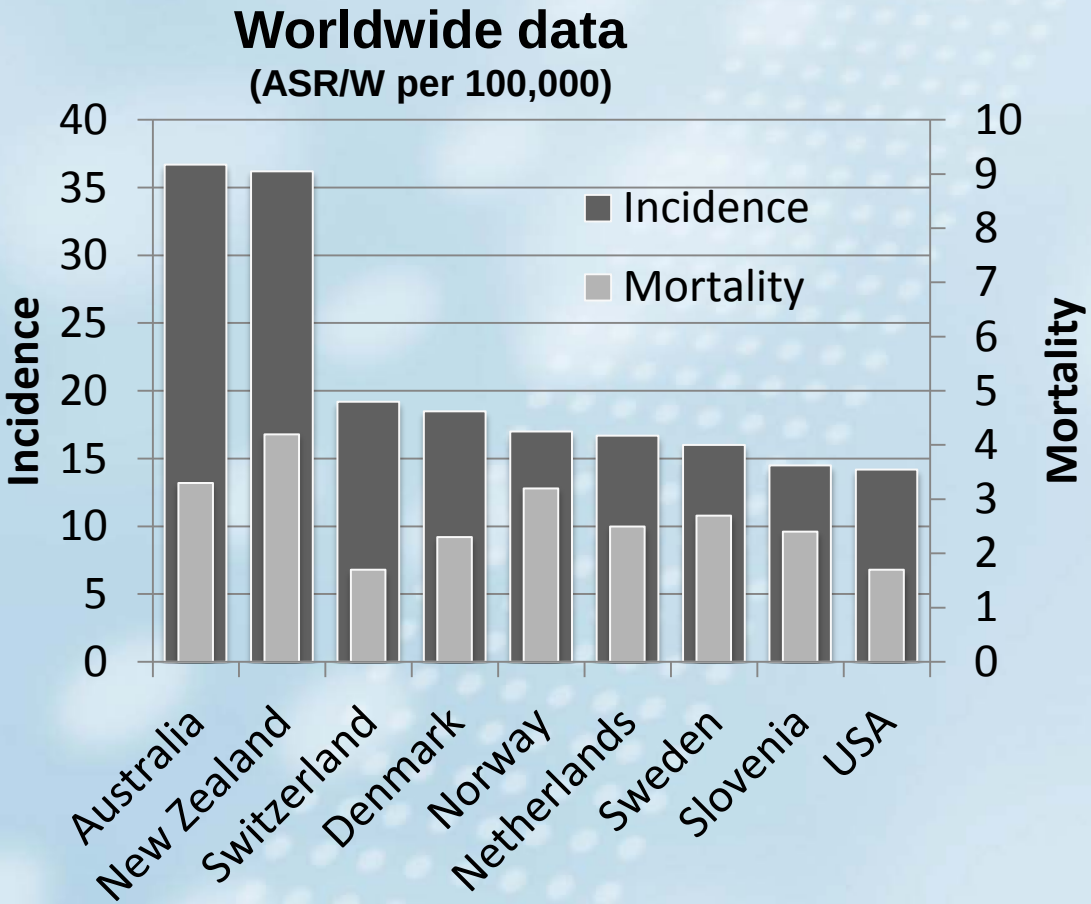
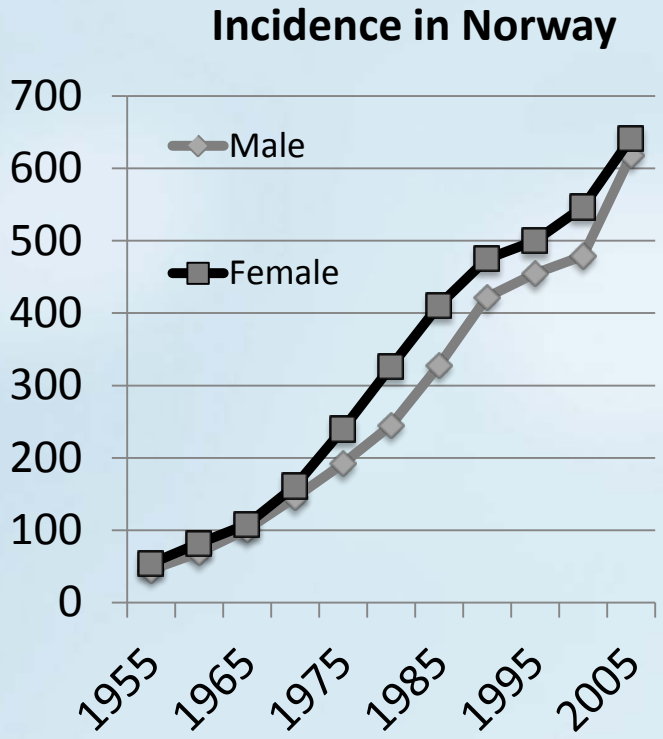
Background

- Melanoma vs benign skin lesion based on dermoscopic imaging.
- GPs Clinical Decision Support tool (triage)
- Machine learning / pattern recognition
- Color is a feature.
- Biopsy still gold standard
- Target: reduce pathology workload

Melanoma statistics



[International Agency for Research on Cancer; 2010. http://globocan.iarc.fr]

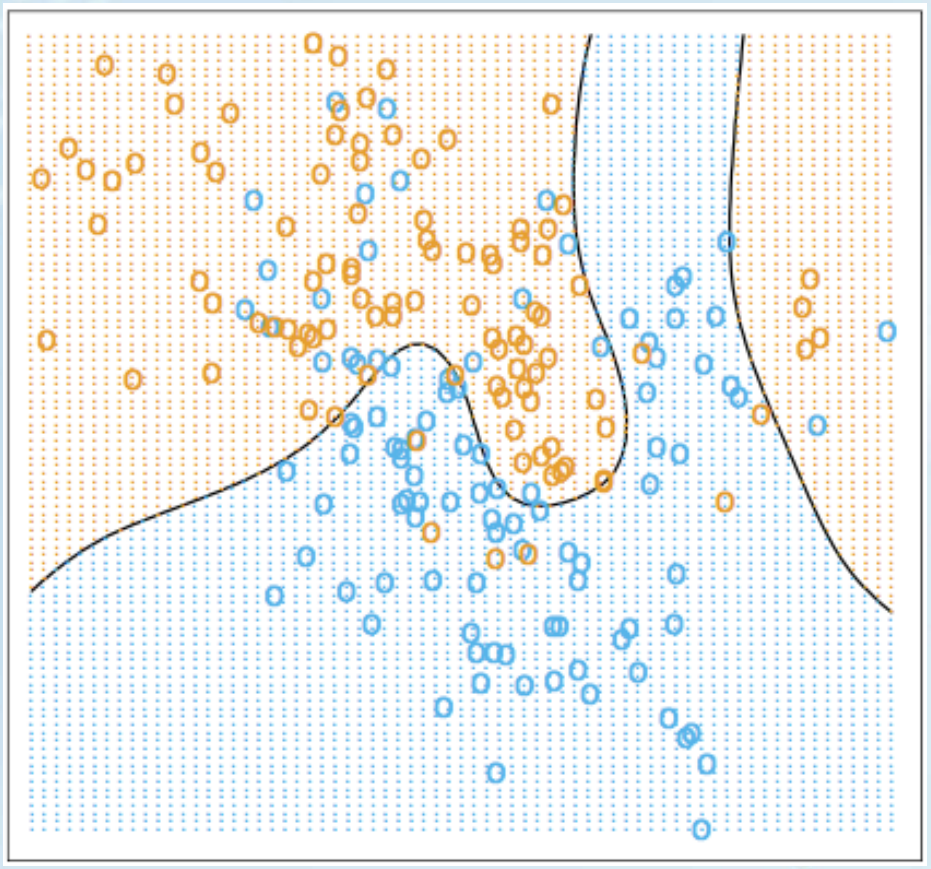


[Cancer in Norway, 2009]

The ABCD(E)-rule

- **A**symmetry
  in shape, color or structures?
- **B**order
  sharply delineated?
- **C**olors
  how many distinct colors are visible?
- **D**ifferential structures
  which of a listed set?
- **E**volution
  is there a change?

Machine learning

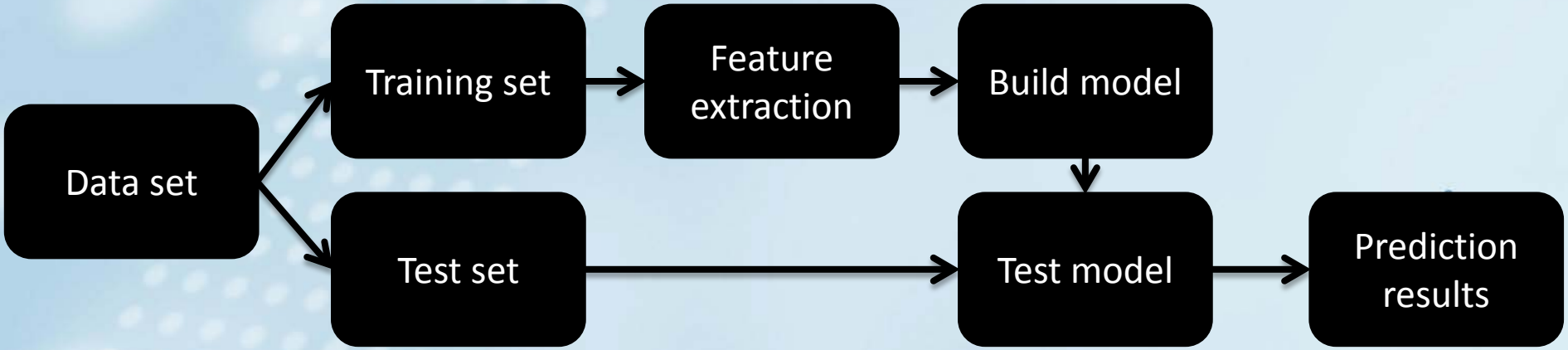


Classification of lesions

1. Segmentation
2. Feature generation
3. Feature selection
4. Classification
5. Validation

$$\text{Sensitivity} = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

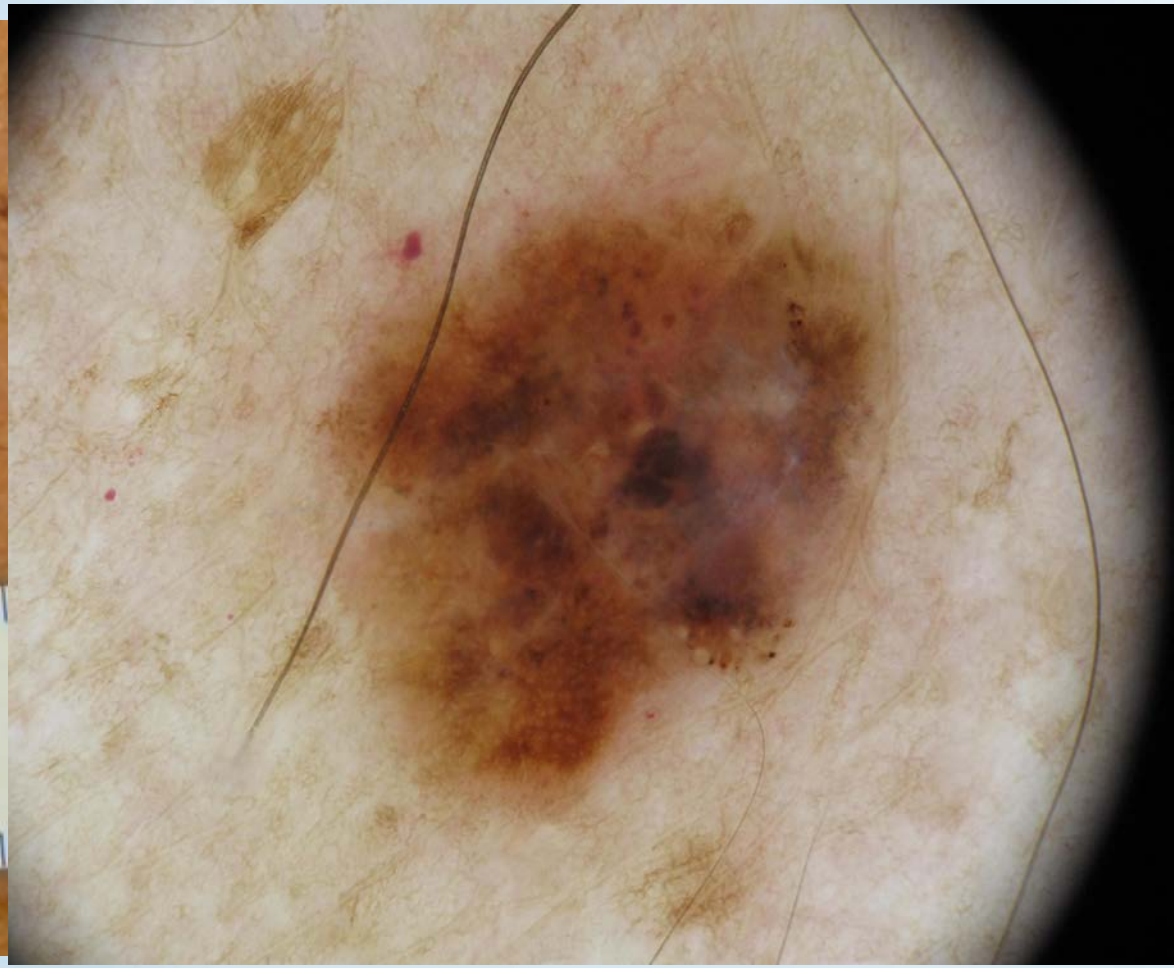
$$\text{Specificity} = \frac{\text{TN}}{\text{TN} + \text{FP}}$$



Dermoscopy

- Provides higher (OR=15.6) diagnostic accuracy compared to visual inspection.
  [Br. J. Dermatol., 2008]
- Dermoscopy is useless without training.
  [Lancet Oncology, 2002]
- Automated diagnosis:
  - Review (2008) found 3 systems in literature, two inferior, one on par with specialists.
    [Semin. Cutan. Med. Surg. 2008]
  - MelaFind®, USA: Sensitivity 98.3%, Specificity: 9.9%.
    [Arch. Dermatol., 2010]
  - Many others not tested thoroughly.
- A solution could lie in multimodal imaging combined with (non-) morphological features.
  [Expert Rev. Anticancer Ther, 2011]

CM
1
2
9



Diagnostic features : color

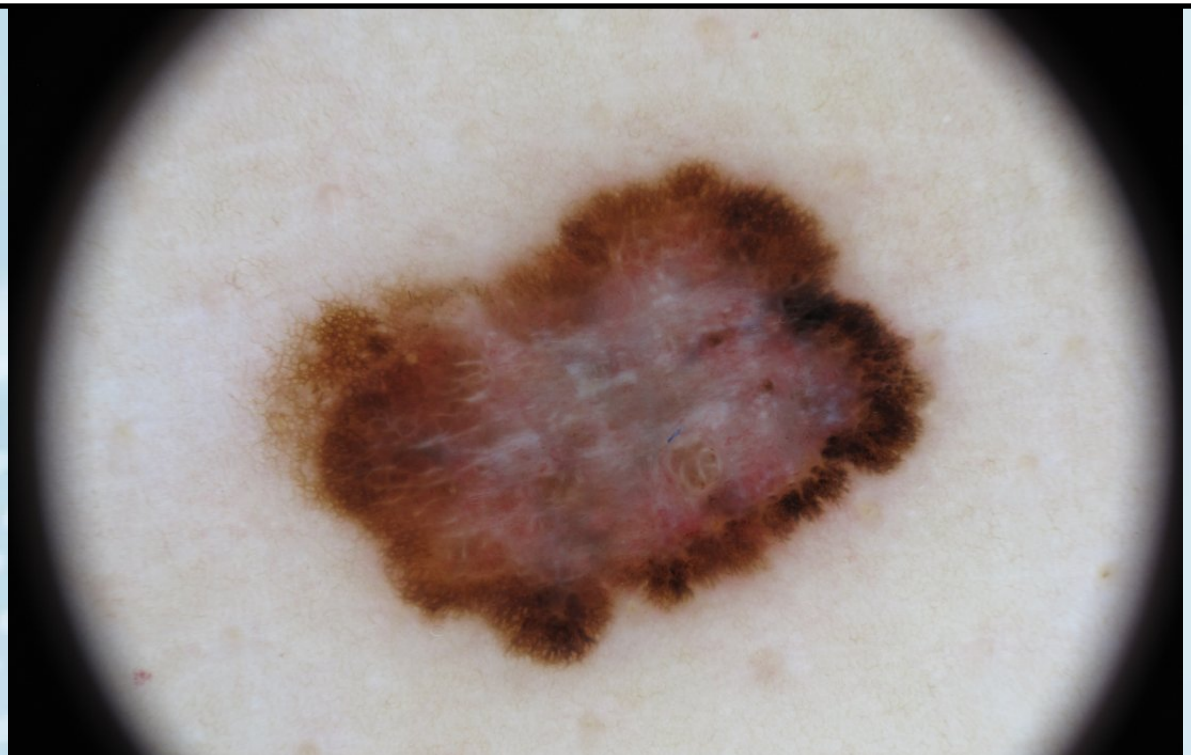
- The number of colors.

- A few distinctive and highly discriminate color, e.g. blue-white veil.

Blue/White veil

An irregular, structureless area of confluent blue pigmentation with an overlying white "ground-glass" haze. The pigmentation cannot occupy the entire lesion and cannot be associated with red-blue lacunes.

[dermoscopy.org]



Current approach

- 53 features are extracted from each image, 11 directly related to color.

- Use perceptually uniform color space CIELab.

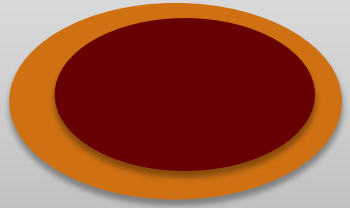
Color features

$$f = [f_1, \ldots, \underbrace{f_{10}, f_{11}, f_{12}}, \underbrace{f_{13}, f_{14}, f_{15}, f_{16}, f_{17}, f_{18}}, \underbrace{f_{19}, f_{20}}, \ldots, f_{53}]$$

Color variability based on 3D histogram.

- Mean # sample in each bin.
- Variance # sample in each bin.
- Pct of non-empty bins.

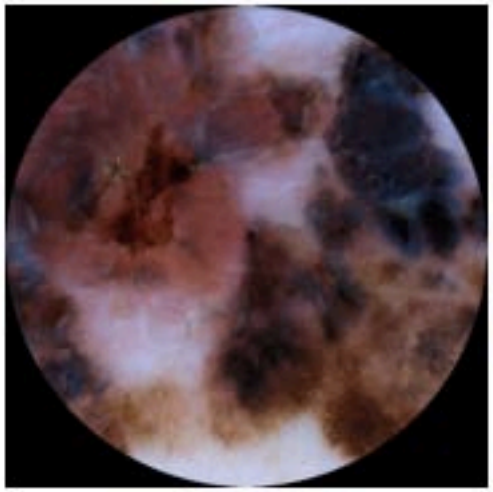
Peripheral vs internal distribution.



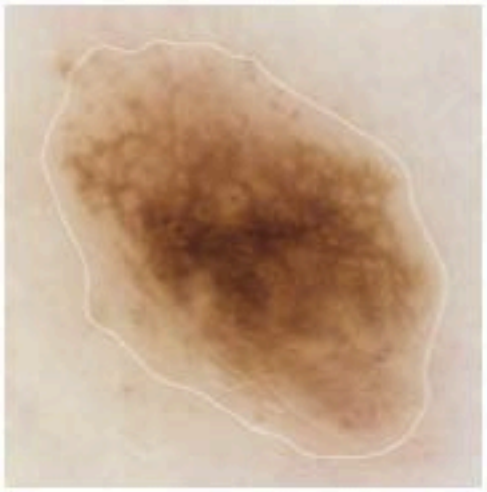
Palette matching

White, red, light brown, dark brown, blue-gray, black.

- # distinct colors
- % blue-gray

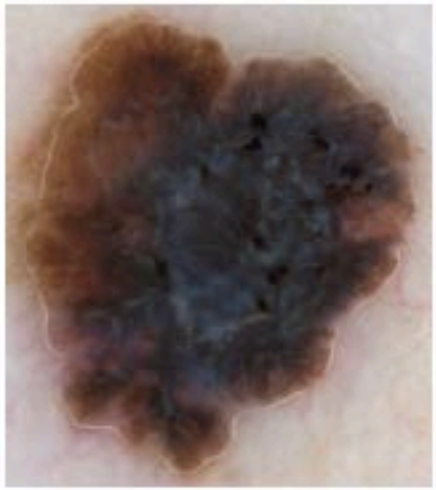


(a) Melanoma with all colors for training

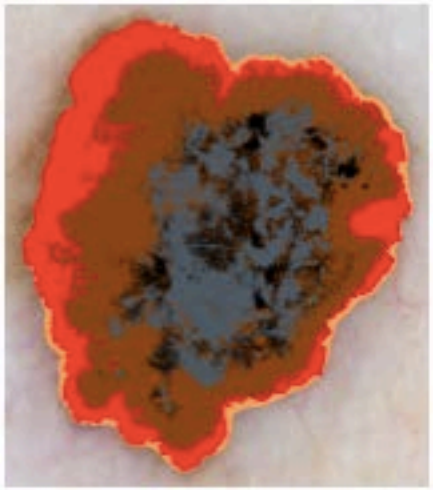


(b) Benign

(c) $f_{19} = 2, f_{20} = 0$

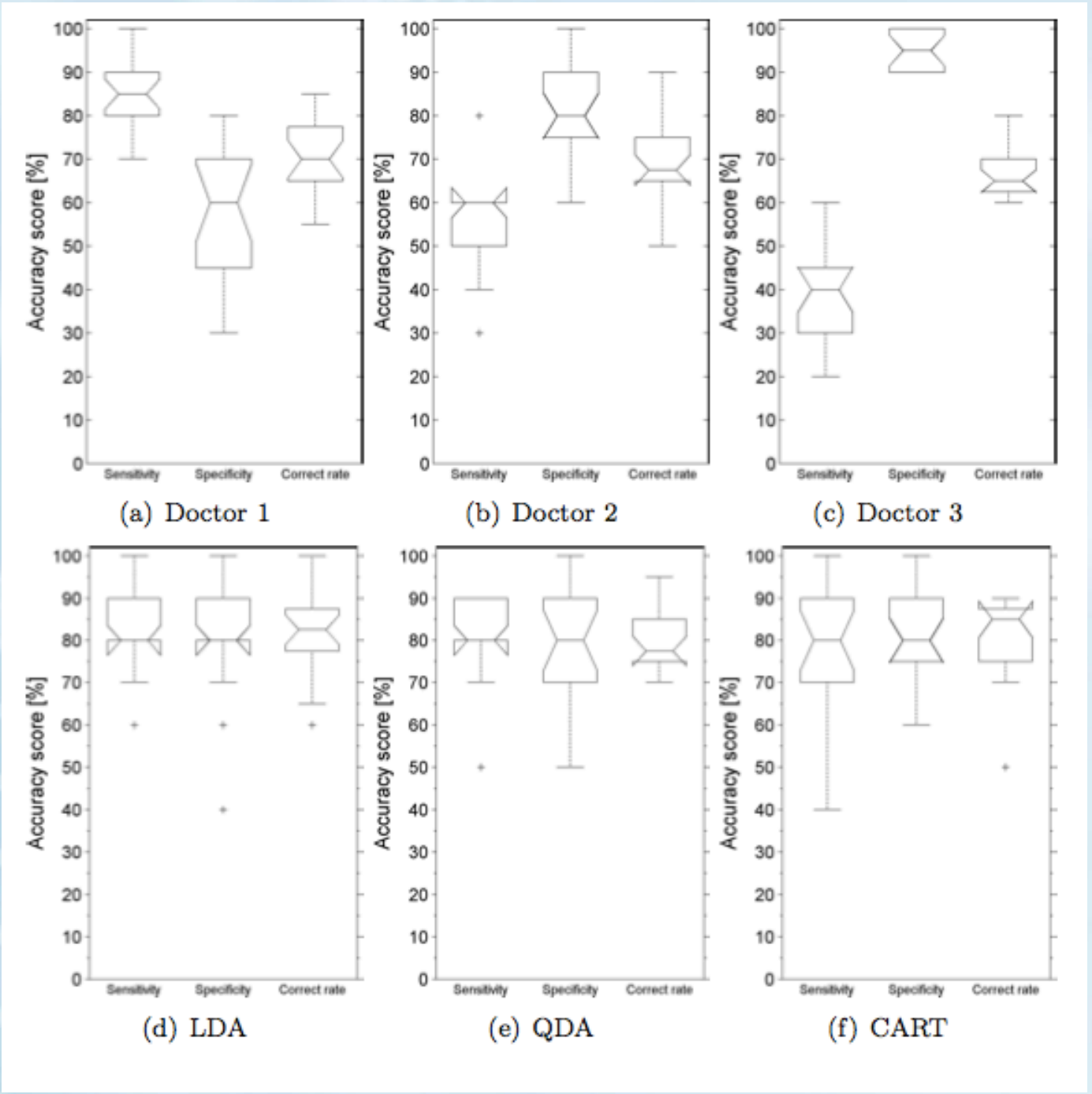


(d) Malignant



(e) $f_{19} = 5, f_{20} = 21$

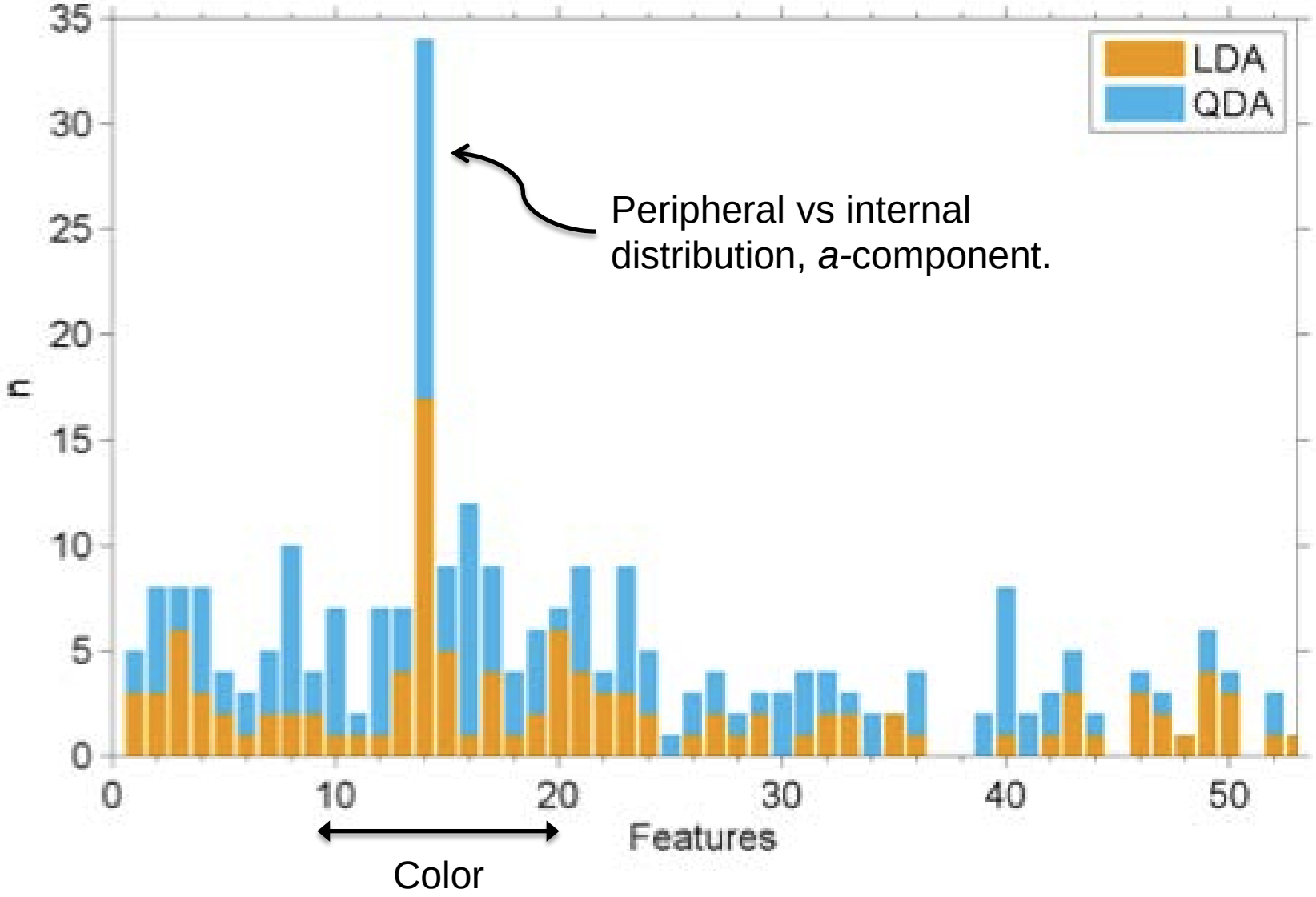
Results



(a) Doctor 1 (b) Doctor 2 (c) Doctor 3

(d) LDA (e) QDA (f) CART

Results, colors



Color counting

- Detect # of colors, not which.
- Color complexity.
- Very difficult to get results corresponding to dermatologist's evaluation.
- Statistically challenging.
- Will be included in the classifier.

General remarks

- In machine learning, features must be consistent.
- The exact specification must be able to extract the relevant feature.
- E.g. what is the feature relevant for the blue-white veil?

Recommendation

- Case: Image-based clinical decision support systems using machine learning methods where color is a feature.
- Color specification must reflect the problem at hand.
- Colors must be consistent.

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References

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