



Universitat  
de les Illes Balears



# Automatic detection of symmetry in dermoscopic images based on shape and texture

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# Skin-lesion Symmetry

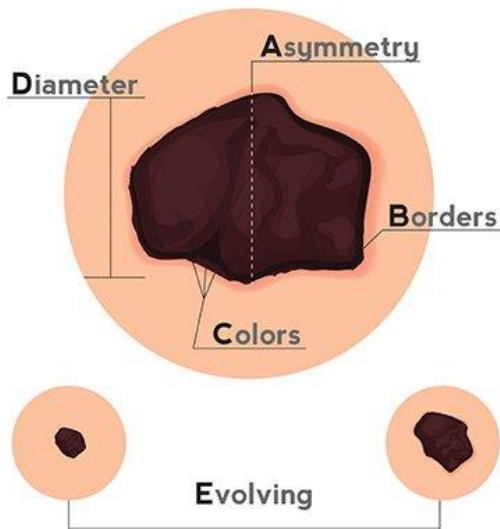


Image source: Cone Health

**Is there CHAOS?**  
**CHAOS is defined as asymmetry of structure or colour**

**THE UNIVERSITY OF QUEENSLAND**  
AUSTRALIA

An Algorithm for the Diagnosis of Malignancy (any type) in Pigmented Skin Lesions by Dermoscopy  
Cliff Rosendahl(a) Alan Cameron(a) Philipp Tschandl(b) Agata Bulinska(c) Jean-Yves Gourhan(d) Sileica Minas(e) Harald Kittler(b)

**CHAOS & CLUES**

**MEDIZINISCHE UNIVERSITÄT WIEN**

**Modified Pattern Analysis (1)**

**Priority Principles**

**CHAOS** Trumps ALL... This includes the ABCD Principle, if a lesion is Structureless and asymmetric, always, always, always, always.

**ABCDE** Principle - Only report to any skin lesion you cannot identify as a "CONVENTIONAL" SPECIFIC BENIGN diagnosis, biopsy is mandatory

**Definitions**

Line - reticular (A), branched (B), parallel (C), radial (D) and curved (E)  
 - A structure with parallel edges whose length is much greater than breadth  
 Pseudopod (F) - a line with a bulbous end  
 Circle (G) - a curved line equidistant from a central point  
 Clod (H) - any well circumscribed solid object larger than a dot with any shape  
 Dot (I) - a tiny round spot  
 Structureless (J) - an area with none of the basic elements dominating

This is a diagrammatic representation of all of the basic structures in this system of modified pattern analysis

**The Algorithm**

**If there is CHAOS and at least one CLUE to malignancy, an adequate BIOPSY is indicated**

**Is there CHAOS?**  
**CHAOS is defined as asymmetry of structure or colour**

This can be assessed at scanning speed. There is no need to describe whether the lesion is melanocytic.

**CHAOS is self-present** from the first lesion. CHAOS is present STOP and EXAMINE for any of CLUES to malignancy.

Self-present means from the first presence of CHAOS. Note that D is asymmetric for pattern and colour (impairment of single axes) not radius.

**CHAOS**

**Exceptions (Malignant lesions which sometimes don't exhibit CHAOS)**

These lesions (which are listed below) should be diagnosed because of the presence of CLUES to malignancy (focal and/or melanocytic) which at these sites should lead to biopsy even if CHAOS is not present or because of the "Priority Principle" of CHAOS (nodular melanocytic and melanocytic melanomas), although benign, should also generally be excised due to frequent difficulty in distinguishing benign lesions.

- Facial melanomas (earrings Melanoma)
- Acral melanomas
- Nodular Melanomas
- Melanotic Melanocytosis

This is an example of a lesion which maligns with the CLUE of "grey structureless" instead of CHAOS

**CLUES**

**Is a CLUE to malignancy present?**

- Eccentric structureless area (grey structureless)
- Thick lines (reticular or branched)
- Black dots or clods, peripheral
- White Lines
- Polymorphous Vessels (2)
- Lines Parallel, Ridges (Palms or Soles)

1. Eccentric structureless area (grey structureless)

2. Thick lines (reticular or branched)

4. Black dots or clods, peripheral (Melanoma)

5. Lines radial or pseudopod (Dots) (black, not pigment) because not "segmented" but "solid" (reticular or branched)

7. Polymorphous vessels (through this lesion, the "white lines" (C) is not pigmented, it is included here)

8. Lines parallel, ridge/reticular (Melanoma)

**Differential Diagnosis of Pigmented Skin Malignancies**

(Not critical because CHAOS & CLUES leads to biopsy anyway)

With only one exception the only malignancy with less reticular is melanoma

Absence of this reticular gives a generalised of all pigmentary malignancies. Some of the vessels are actually pigmented brown in situ (not white) and are not reticular. This is a common feature of (AJD) in situ melanoma.

Lines radial (parietal) of a common lesion are specific for BCC

**Evaluation of CHAOS & CLUES**

**Assessment of 482 consecutive pigmented lesions - Dermatoscopy and Clinical (Diagnostic) description**

Specificity: 97.6%

Sensitivity (any malignancy): 95.6%

Chaotic and clues point to malignant lesions but additional histopathological investigation can be employed with confidence by pattern analysis

Sensitivity (any malignancy): 90.0%

Specificity: 97.6%

**Assessment of 122 consecutive melanocytic lesions by 3 dermatoscopists comparing papers 1, 2 and 3, ABCD, Whiteness and Clues (C)**

Philipp Tschandl, Alan Cameron, Cliff Rosendahl, Harald Kittler

**ROC Threshold**

The 95% Confidence Interval of the Area of all algorithms, including the new and general system, was significantly superior to algorithm accuracy

**Affiliations**

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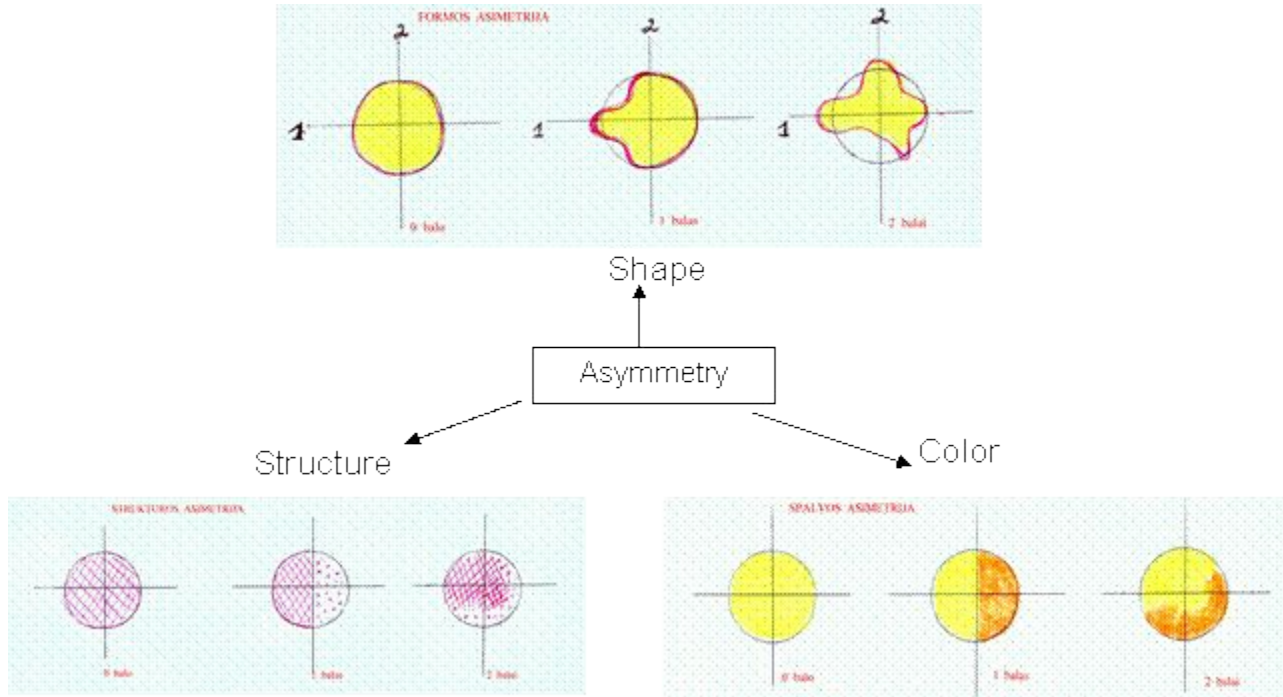
**References**

1. Koller, S. Dermatoscopy: diagnosis of a new differential method based on pattern analysis for detection of pigmented skin lesions. *Dermatology* 2004; 209: 100-105.  
 2. Koller, S., Tschandl, P., Kittler, H. (2004) Computerized pigmented lesion analysis: a new classification of pigmented lesions based on a...  
 3. Koller, S., Tschandl, P., Kittler, H. (2004) Computerized pigmented lesion analysis: a new classification of pigmented lesions based on a...  
 4. Koller, S., Tschandl, P., Kittler, H. (2004) Computerized pigmented lesion analysis: a new classification of pigmented lesions based on a...  
 5. Koller, S., Tschandl, P., Kittler, H. (2004) Computerized pigmented lesion analysis: a new classification of pigmented lesions based on a...

For more information and a high-resolution PDF of this poster go to [www.medicineshop.com](http://www.medicineshop.com)  
 This poster is an illustrated guide only. Study of the material on this web-site is recommended

Rosendahl, Cliff, et al. "Dermoscopy in routine practice: Chaos and clues." *Australian family physician* 41.7 (2012): 482.

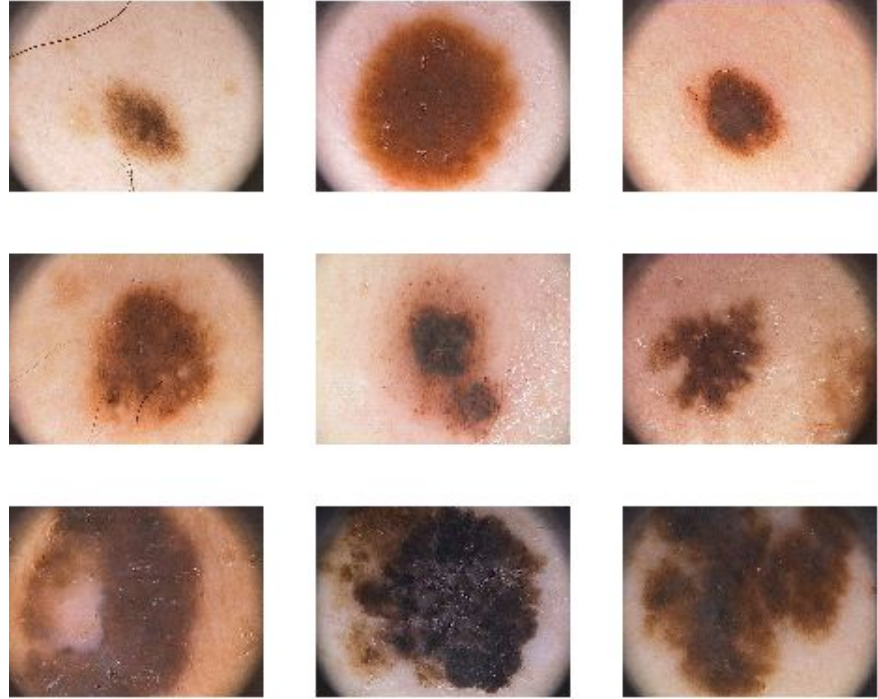
# Skin-lesion Symmetry



Source: Science Prog

# Material

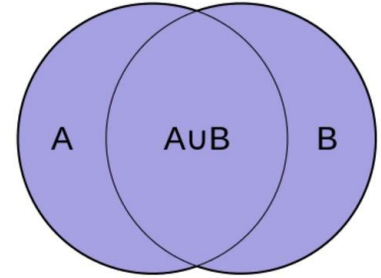
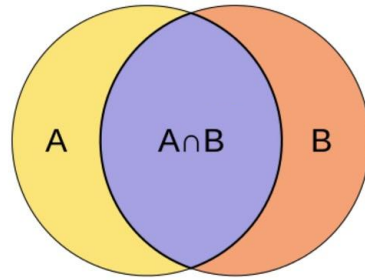
- PH<sup>2</sup> Dataset
- Jaccard Index
- Random Forests
- Patches Dataset



Mendonça, T. F., et al. "PH2: A public database for the analysis of dermoscopic images." *Dermoscopy image analysis* (2015).

# Material

- PH<sup>2</sup> Dataset
- Jaccard Index
- Random Forests
- Patches Dataset



$$J(A, B) = \frac{|A \cap B|}{|A \cup B|}$$

# Material

- PH<sup>2</sup> Dataset
- Jaccard Index
- Random Forests
- Patches Dataset

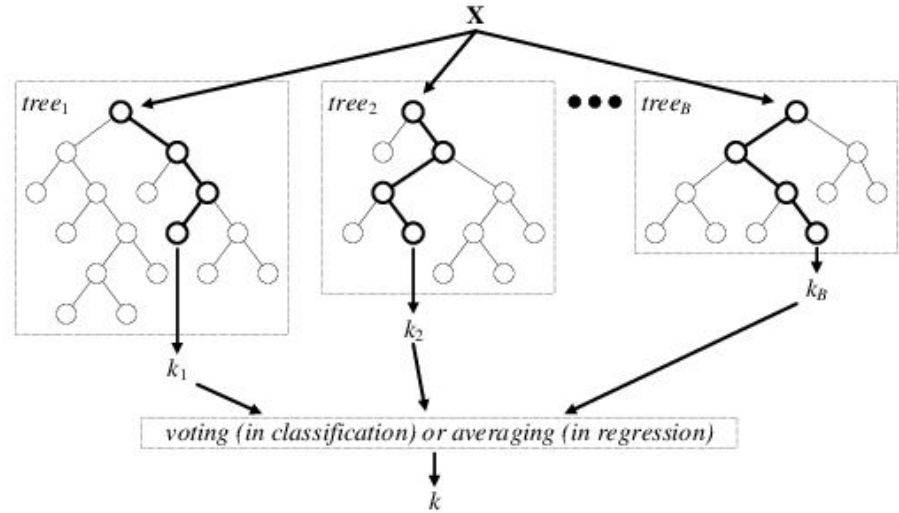


Image source: Antanas Verikas et al.

# Material

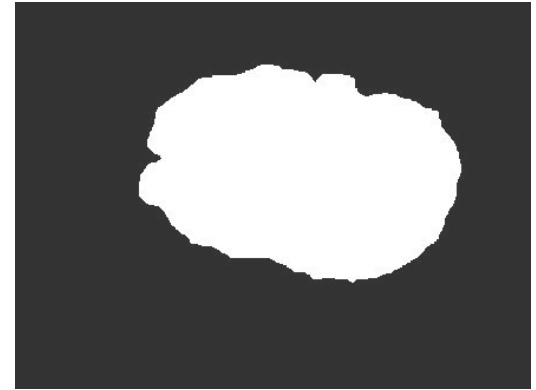
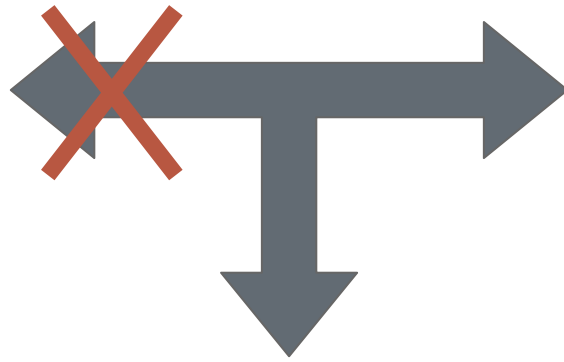
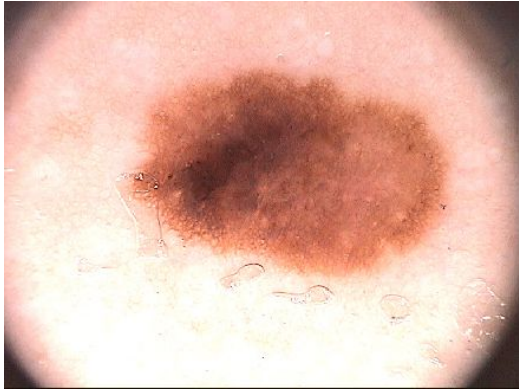
- PH<sup>2</sup> Dataset
- Jaccard Index
- Random Forests
- Patches Dataset



# Symmetry Method: Based on Shape

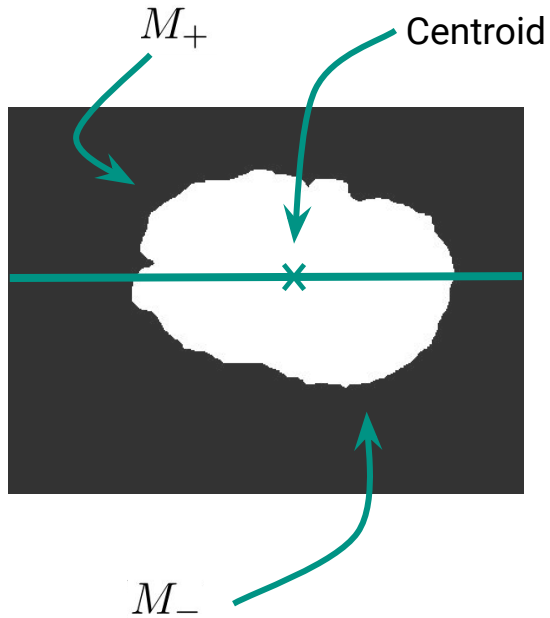


# Shape-Based Method



**Symmetry  
Based on Shape**

# Shape-Based Method

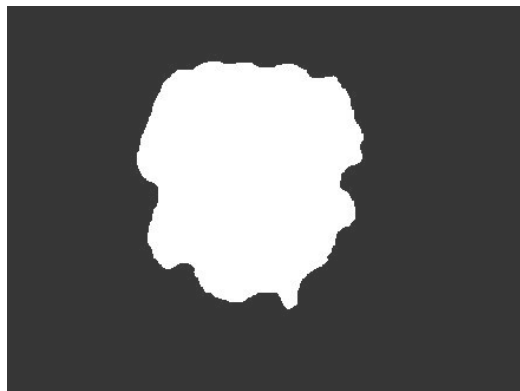
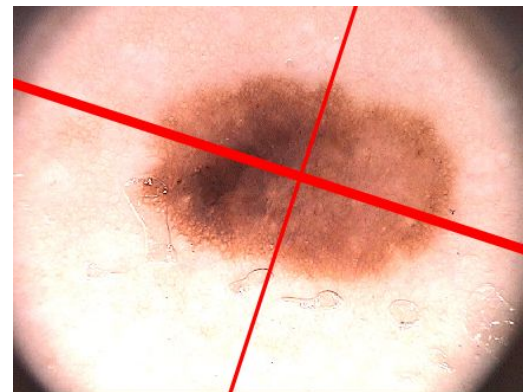
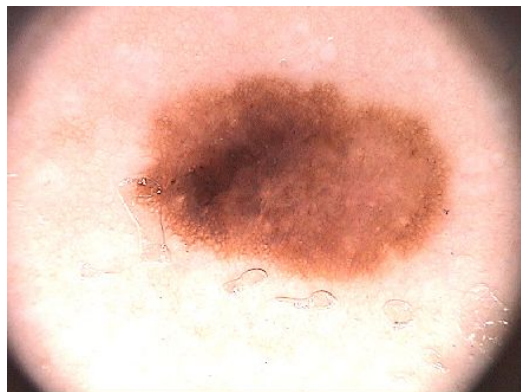


$$S_1(\ell) = \frac{|M_+ \cap R_\ell(M_-)|}{|M_+ \cup R_\ell(M_-)|}.$$



	"Shape" Symmetry
0°	
15°	
30°	
...	
175°	

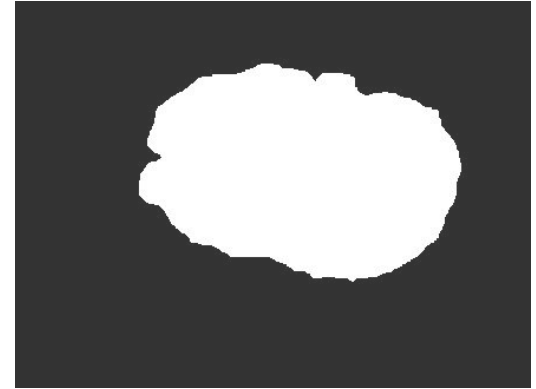
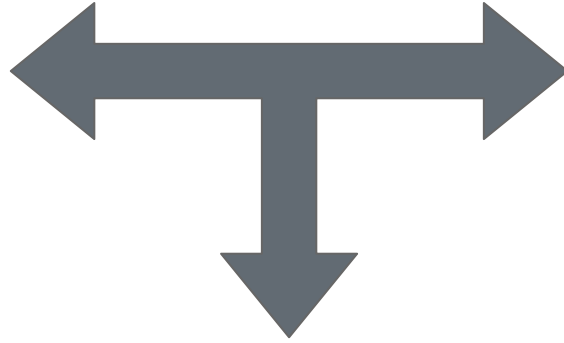
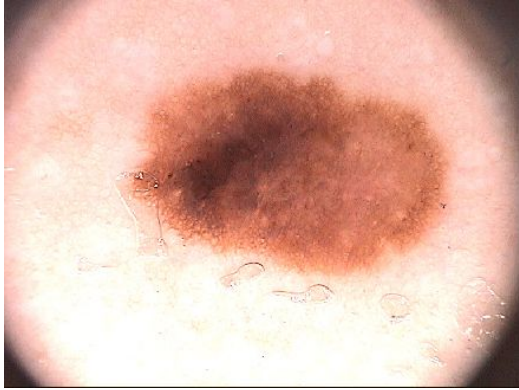
# Shape-Based Method



# Symmetry Method: Based on Texture



# Texture-Based Method



**Symmetry  
Based on Texture**

# Material

- PH<sup>2</sup> Dataset
- Jaccard Index
- Random Forests
- Patches Dataset

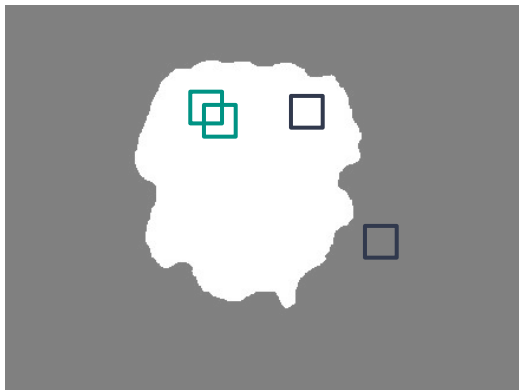
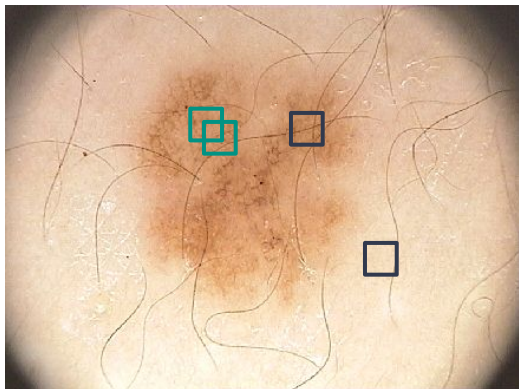


Similar Pairs

vs

Non-Similar Pairs

# Patches Dataset



## Similar pairs:

- Close (partially overlapping)
- Both within or without the lesion

## Non-similar pairs:

- One within the lesion, one without the lesion

10+10 pairs from each  
of the 200 samples.



# Patches Dataset



**Random Forest Classifier**



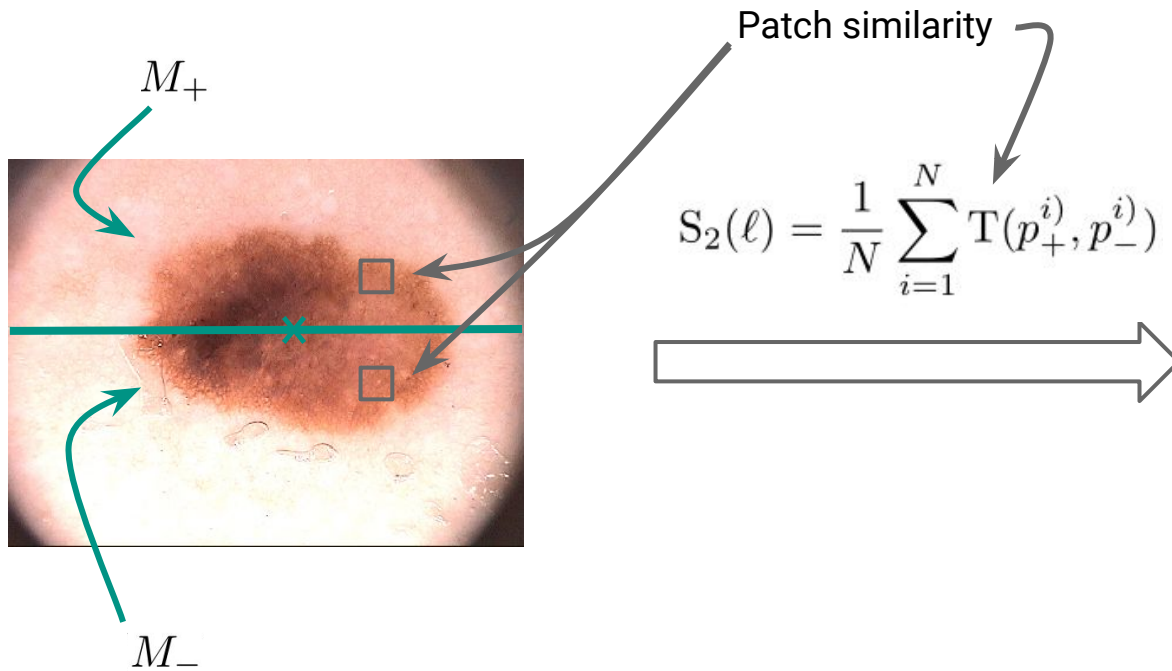
Two classes:

- Similar (2000 samples)
- Non-similar (2000 samples)

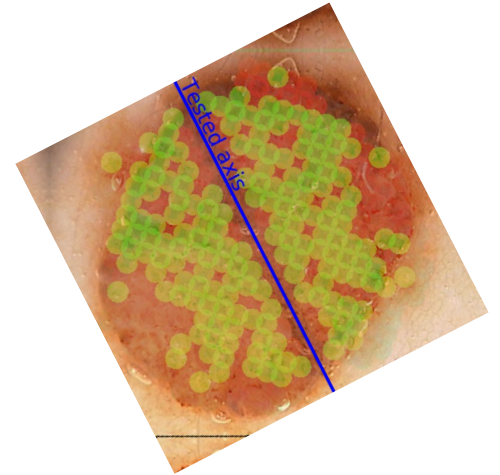
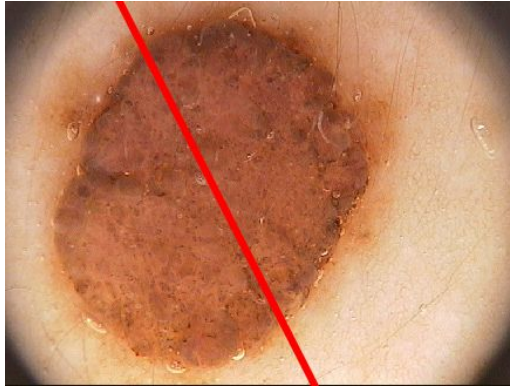
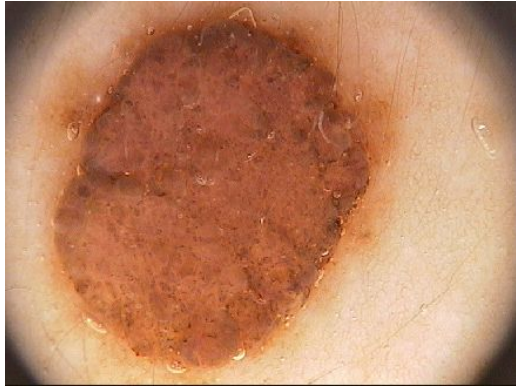
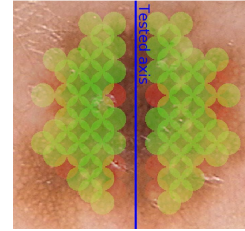
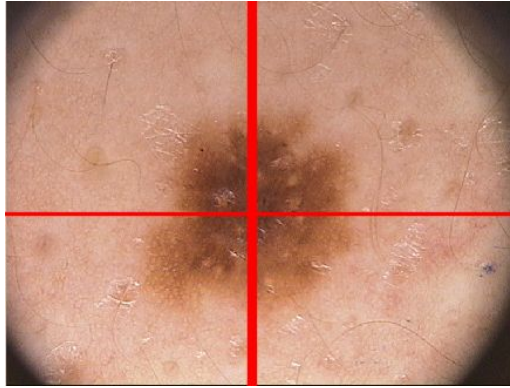
Textural features:

- GLCM features
- Per-channel histogram

# Texture-Based Method



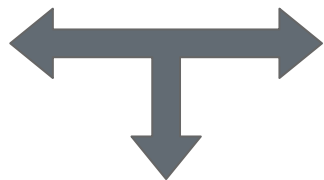
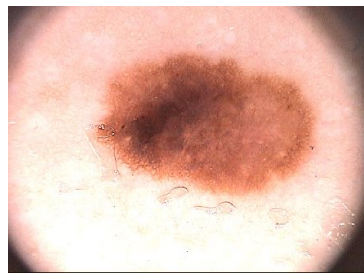
# Texture-Based Method



# Symmetry Method: Overall Symmetry



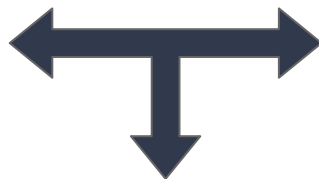
# Overall Symmetry



**Symmetry  
Based on Texture**



**Symmetry  
Based on Shape**



**Symmetry  
Based on Shape  
and Texture**

# Overall Symmetry

	"Shape" Symmetry	"Texture" Symmetry
0°		
15°		
30°		
...		
175°		

## Random Forest Classifier



PH<sup>2</sup> dataset:

- Training (50 samples)
- Test (150 samples)

Three classes:

- No symmetry (26%)
- One-axis symmetry (15.5%)
- Two-axes symmetry (58.5%)

Patches dataset might have leaked some bits of information

# Results

Classifier	Accuracy
Based on shape	86%
Based on texture	84%
Based on both	88%

# Limitations

- Lack of comparison
- Patches dataset:
  - Biased
  - Limited amount of textures
- Study bias: light-skin patients



# Contributions and software

- Patches dataset
- Symmetry detection
  - Only-shape and only-texture symmetry.
  - Overall symmetry.

[Python package] dermoscopic-symmetry

<https://pypi.org/project/dermoscopic-symmetry/>

[Online demo] DermaWeb

[http://dermaweb.uib.es/d/algorithm/dermoscopy\\_shape\\_symmetry/](http://dermaweb.uib.es/d/algorithm/dermoscopy_shape_symmetry/)

[http://dermaweb.uib.es/d/algorithm/dermoscopy\\_texture\\_symmetry/](http://dermaweb.uib.es/d/algorithm/dermoscopy_texture_symmetry/)

# Thank you



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