Automatic classification of skin lesions using geometrical measurements of adaptive neighborhoods and local binary patterns

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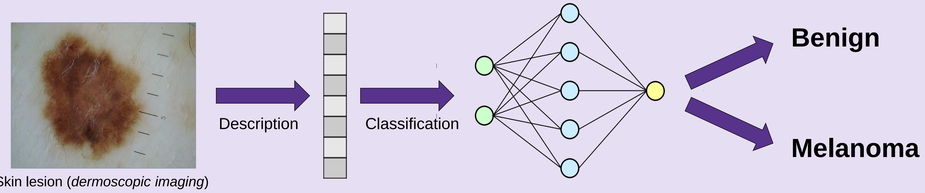
Context

Computer-Aided Diagnosis



Skin lesion (*dermoscopic imaging*)

Methods

General Adaptive Neighborhoods (GANs)

The **GAN** of a point $\boldsymbol{x}$ is a **spatial neighborhood** whose size and shape is adapted to the local features of the image.

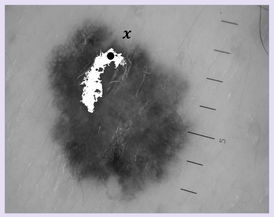
Definition

- The intensities of its points are close to that of the seed point according to a selected criterion (e.g., luminance, contrast...).
- The GAN is a **path connected** set.

$$V_m^h(x) = C_{\{y \in D : |h(y) - h(x)| \leq m\}}(x)$$

where:

- $\boldsymbol{D}$: Spatial support, ($D \subseteq \mathbb{R}^2$)
- $\boldsymbol{h}$: Criterion mapping, ($h: D \rightarrow \mathbb{R}$)
- $\boldsymbol{m}$: Tolerance homogeneity
- $\boldsymbol{C_X(x)}$: Path connected component of X containing x



GAN of a point $\boldsymbol{x}$ (h: luminance, m = 20)

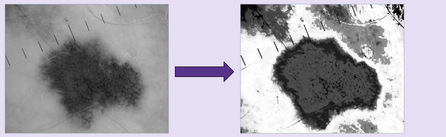
GAN-based Minkowski Map (Local Characterization)

Definition

$$\mu_m^h(x) = \mu(V_m^h(x))$$

where $\boldsymbol{\mu}$ is a **Minkowski functional**:

- Area ($\boldsymbol{A}$)
- Perimeter ($\boldsymbol{P}$)
- Euler Number (χ)



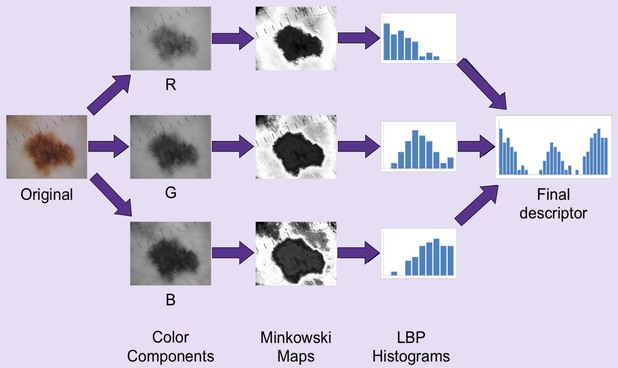
Original image (h: luminance)

GAN-based Minkowski map : $A(V_{20}^h(x))$

Image Description (Skin Lesion Features)

The **final image descriptor** is built in two steps:

- The GAN-based Minkowski map (with $\mu = A$) of the color components R, G and B of the original image is computed.
- The **Local Binary Pattern** ($LBP_{P,R}$) operator of each of these maps is computed, and the three histograms are concatenated.



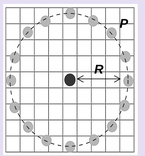
Experiments

Dataset

1097 dermoscopic images of pigmented skin lesions: 88 of them histopathology confirmed melanomas.

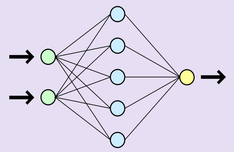
Descriptor parameters

- GAN-based Minkowski maps
  - m = 20
  - μ = A (area)
- $LBP_{P,R}$
  - P fixed to 8
  - R varying from 1 to 6



Classification

- Feed-forward neural network
- One hidden layer
- Sigmoid transfer function
- 10-fold cross validation



Results

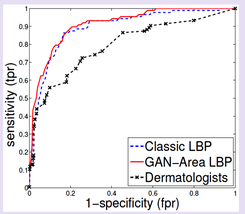
- Area under ROC curve.
- Different neurons in hidden layer and training cycles.
- Comparison with classical LBP.

R	Num. neurons	Num. cycles	AUC
1	10	300	0.8726
2	7	300	**0.8948**
3	7	400	0.8934
4	5	500	0.8946
5	7	400	0.8895
6	10	400	0.8898

Classical LBP

R	Num. neurons	Num. cycles	AUC
1	10	500	0.8547
2	10	500	0.8780
3	10	500	0.8934
4	7	300	0.8976
5	10	500	0.9052
6	10	500	**0.9115**

The proposed method: GAN-Area LBP



ROC curve

Conclusion and Perspectives

Conclusion

- Classification of color images of naevi as benign lesions or melanoma.
- Descriptor built upon LBP and local geometrical features.
- Performance evaluated and compared with the classical LBP and the dermatologists' predictions.
- AUC: 0.792 (Dermatologists); 0.8948 (Classical LBP); **0.9115** (Proposed method).

Perspectives

- Assess other GAN-based geometrical and/or morphometrical features.
- Automatic selection of relevant features.

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