



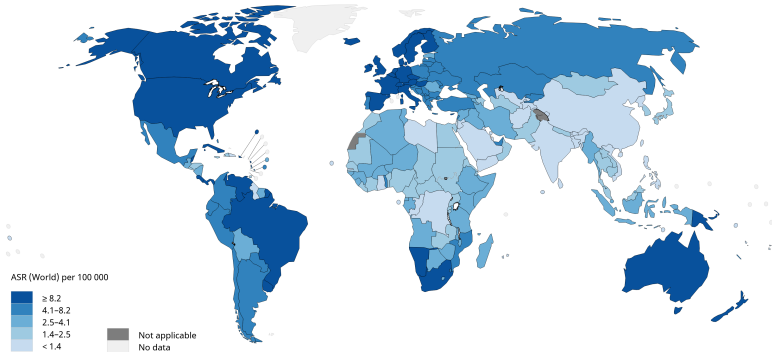
Recent advances in deep learning applied to skin cancer detection

André Pacheco
Federal University of Espírito Santo
`agcpacheco@inf.ufes.br`

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- Skin cancer is the most common type of cancer worldwide

Estimated age-standardized incidence rates (World) in 2018, both sexes, all ages



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Data source: GLOBOCAN 2018
Graph production: IARC
(<http://gis.scribbr.com>)
World Health Organization

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Research on Cancer 2018

- Strong **lack** of qualified professionals and medical instruments
- Computer-aided diagnosis (CAD) systems are very desired



- **Deep learning** methods have been achieving remarkable results

Dermatologist-level classification of skin cancer with deep neural networks

Andre Esteve^{1*}, Brett Kuper^{1*}, Roberto A. Novoa^{2,3}, Justin Ko², Susan M. Swetter^{2,4}, Helen M. Blau⁵ & Sebastian Thrun⁶

Automated Melanoma Recognition in Dermoscopy Images via Very Deep Residual Networks

Lequan Yu,^{*} Student Member, IEEE, Hao Chen, Student Member, IEEE, Qi Dou, Student Member, IEEE, Jing Qin, Member, IEEE, and Pheng-Ann Heng, Senior Member, IEEE

Classification of the Clinical Images for Benign and Malignant Cutaneous Tumors Using a Deep Learning Algorithm

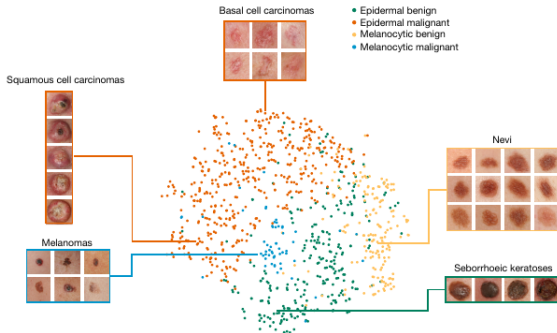
Seung Seog Han^{1,2}, Myoung Shin Kim^{1,2}, Woohyung Lim³, Gyeong Hun Park⁴, Ilwoo Park⁵ and Sung Eun Chang⁶

Skin Lesion Classification Using Convolutional Neural Network With Novel Regularizer

MARWAN ALI ALBAHAR[✉]
The Royal College for Management Sciences, Altha, Saudi Arabia
(e-mail: marwanalibahar@gmail.com)

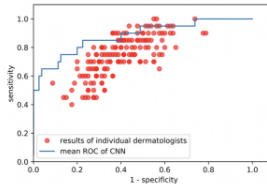
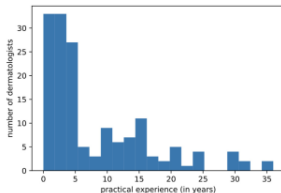
Deep learning ensembles for melanoma recognition in dermoscopy images

Deep learning applied to skin cancer detection



- InceptionV3
- 757 types of skin diseases
- Competitive performance comparing to 21 dermatologists

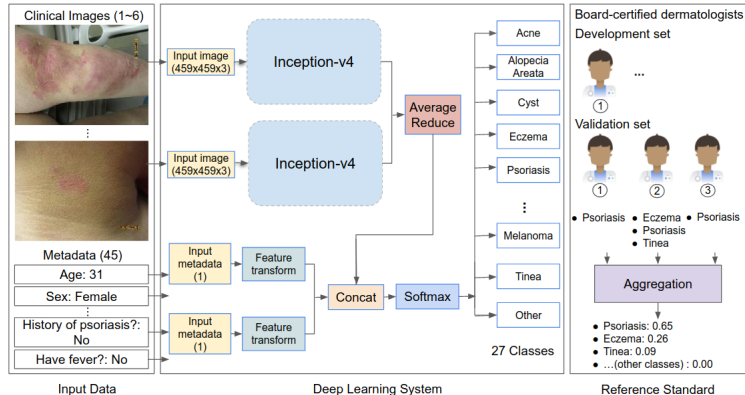
Esteva, Andre, et al. "Dermatologist-level classification of skin cancer with deep neural networks." *Nature* 542.7639 (2017): 115.



- Resnet-50
- The model outperformed 136 out of 157 dermatologists

Brinker, Titus J., et al. "Deep learning outperformed 136 of 157 dermatologists in a head-to-head dermoscopic melanoma image classification task." *European Journal of Cancer* 113 (2019): 47-54.

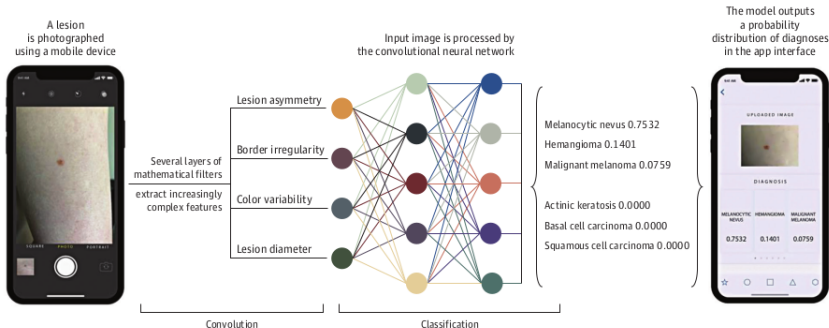
Deep learning applied to skin cancer detection



- 26 skin diseases
- Images and patient metadata

Liu, Yuan, et al. "A deep learning system for differential diagnosis of skin diseases." arXiv preprint arXiv:1909.05382 (2019).

The rise of smartphone apps



Zakhem, George A., Catherine C. Motosko, and Roger S. Ho. "How should artificial intelligence screen for skin cancer and deliver diagnostic predictions to patients?." JAMA dermatology 154.12 (2018): 1383-1384.

1. Dataset
2. Interpretability
3. Privacy, ethics and safety

- There is a lack of open datasets
- International Skin Imaging Collaboration (ISIC)
 - Archive of dermoscopic images
- There is no open archive for **clinical images**
 - Essential for smartphone apps

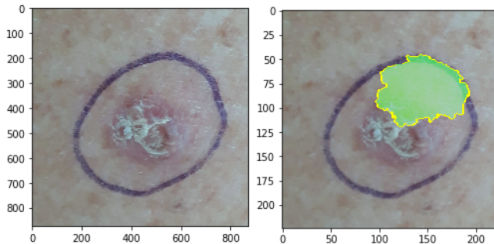
1. Dataset



- Clinical images and patient demographics

Pacheco, Andre G.C., and Renato A. Krohling. "The impact of patient clinical information on automated skin cancer detection." Computers in biology and medicine (2019).

- Relatively small datasets lead to **bias!**
- Ex:
 - Ethnicity or type of skin
 - Artifacts on the images



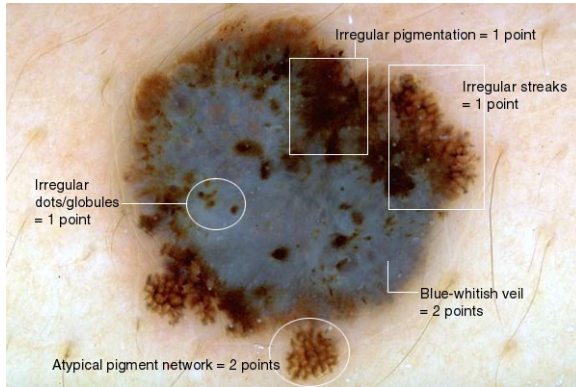
1. Dataset
2. **Interpretability**
3. Privacy, ethics and safety

2. Interpretability

- Presenting only probabilities is not enough
- Dermatologists and clinicians are interested in insights and visual explanations
 - **Why** this lesion instead of only **which** lesion.
- Interpretability brings the clinicians to the decision process
 - Focus on **assistentment** instead of **replacement**

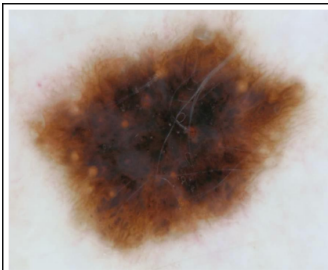
2. Interpretability

- Attribute detection instead of only lesion prediction



Dermoscopy. 7-point checklist, 2019. <http://www.dermoscopy.org/consensus/2d.asp>

- Visual Question & Answering (VQA) for skin cancer detection



- **Is the atypical pigment network present?**
- **Is the border irregular?**
- **Are there irregular streaks?**
- **Is there a blue-whitish veil?**

Challenges and opportunities

1. Dataset
2. Interpretability
3. **Privacy, ethics and safety**

3. Privacy, ethics and safety

- Smartphone apps have the potential to deal with the lack of dermatoscope
 - Many are available on the internet for self-examination
- This is a great tool, but we must be careful
 - *"With great power comes great responsibility"*
- These apps also have the potential to **harm** the user/patient
 - Miss-classifications may lead to **false sense of security** or **unnecessary worry**

3. Privacy, ethics and safety

- Most of the apps do not provide:
 - Disclosure of authorship
 - Data transparency
 - Scientific evidence of their performance

Chao, Elizabeth, Chelsea K. Meenan, and Laura K. Ferris. "Smartphone-based applications for skin monitoring and melanoma detection." *Dermatologic clinics* 35.4 (2017): 551-557.

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3. Privacy, ethics and safety

- Most of the apps do not provide:
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- **Can we trust these apps?**

- **Should these apps be available to general users with no expert supervision?**

- Deep learning has become the standard approach to deal with skin cancer detection
- We need to focus more in interpretability
 - It is not man against machine!
- Smartphone apps have a strong potential
 - But important issues must be addressed before make it available to users

Thank you for your time!



Andre Pacheco
agcpacheco@inf.ufes.br
<http://pachecoandre.com.br>