# Computational Dermatology - Developing and Testing Algorithms to Segment Images Based on Hair Density

**Students**:
Siddhi Velankar, MS EE
Tejas Mane, MS SCMP
Wenbo Zhang, MS SCMP
**Supervisor**:
Elena Bernardis, PhD

# Alopecia Areata (AA) introduction

## Clinical motivation?

- 6.8 million people in the US, 147 million worldwide[1].
- Quantifying abnormal hair density needed to track progression.

## Current Methods

- Simple diameter measurement methods used.
- Severity of Alopecia Tool (SALT) score.
- CHOP's Alopecia app.

## What we want!

- Quick, reliable and consistent quantification methods.
- Development of a computer-based automated segmentation tool.

[1] www.naaf.org - National Alopecia Areata Foundation 2018

# Pediatric Alopecia Areata dataset

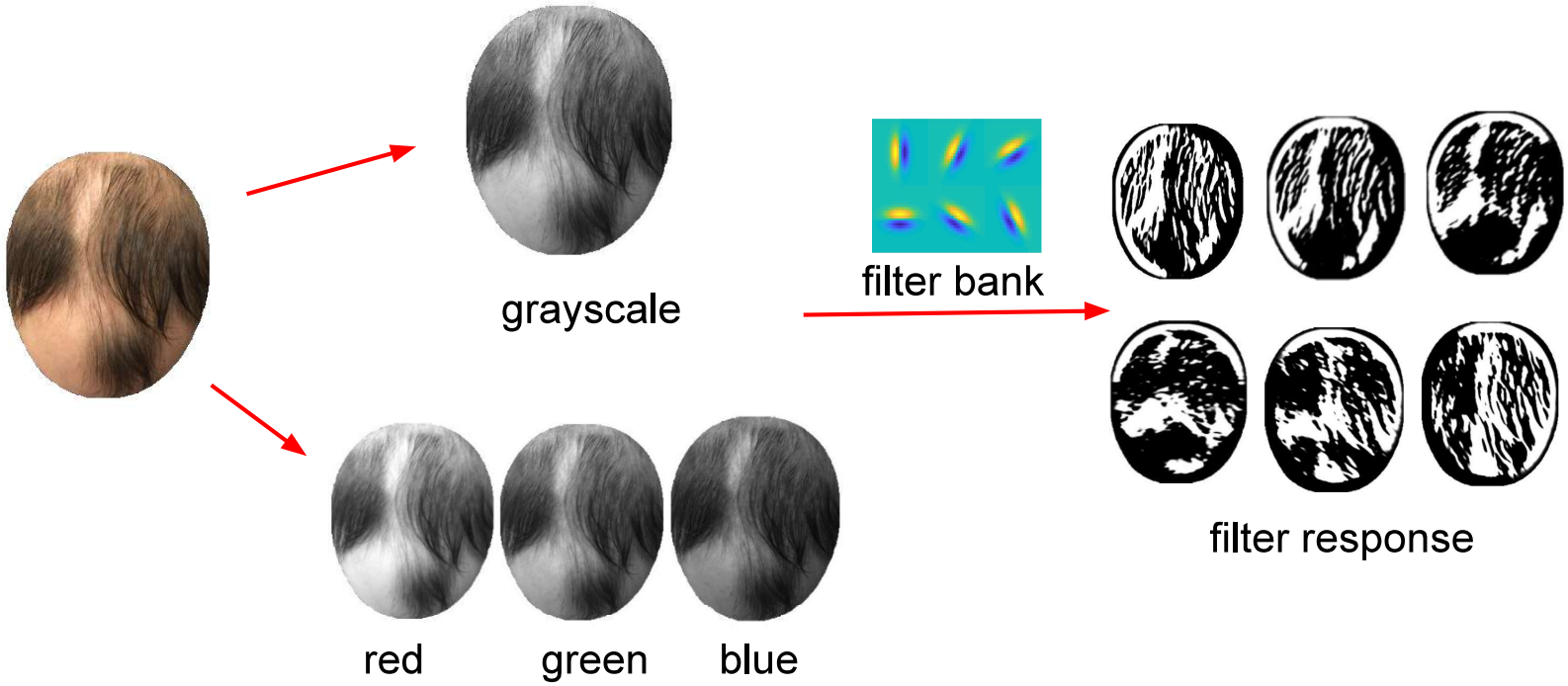
- 251 de-identified images from CHOP's hair clinic
- Four different orientation (left, back, top, right)

- Manually labelled masks

# Feature exploration

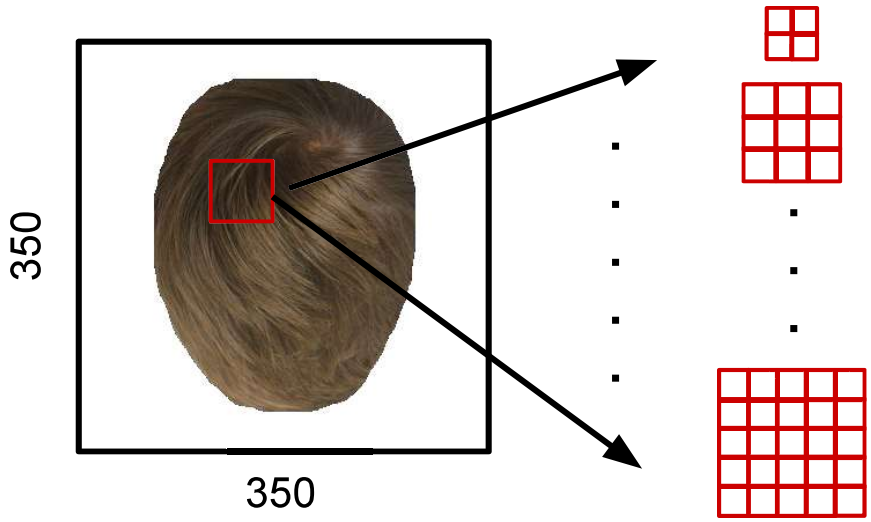
Pixel ⟷ hair density information

- Color channels
- Filter responses



# Feature exploration: pixels to patches

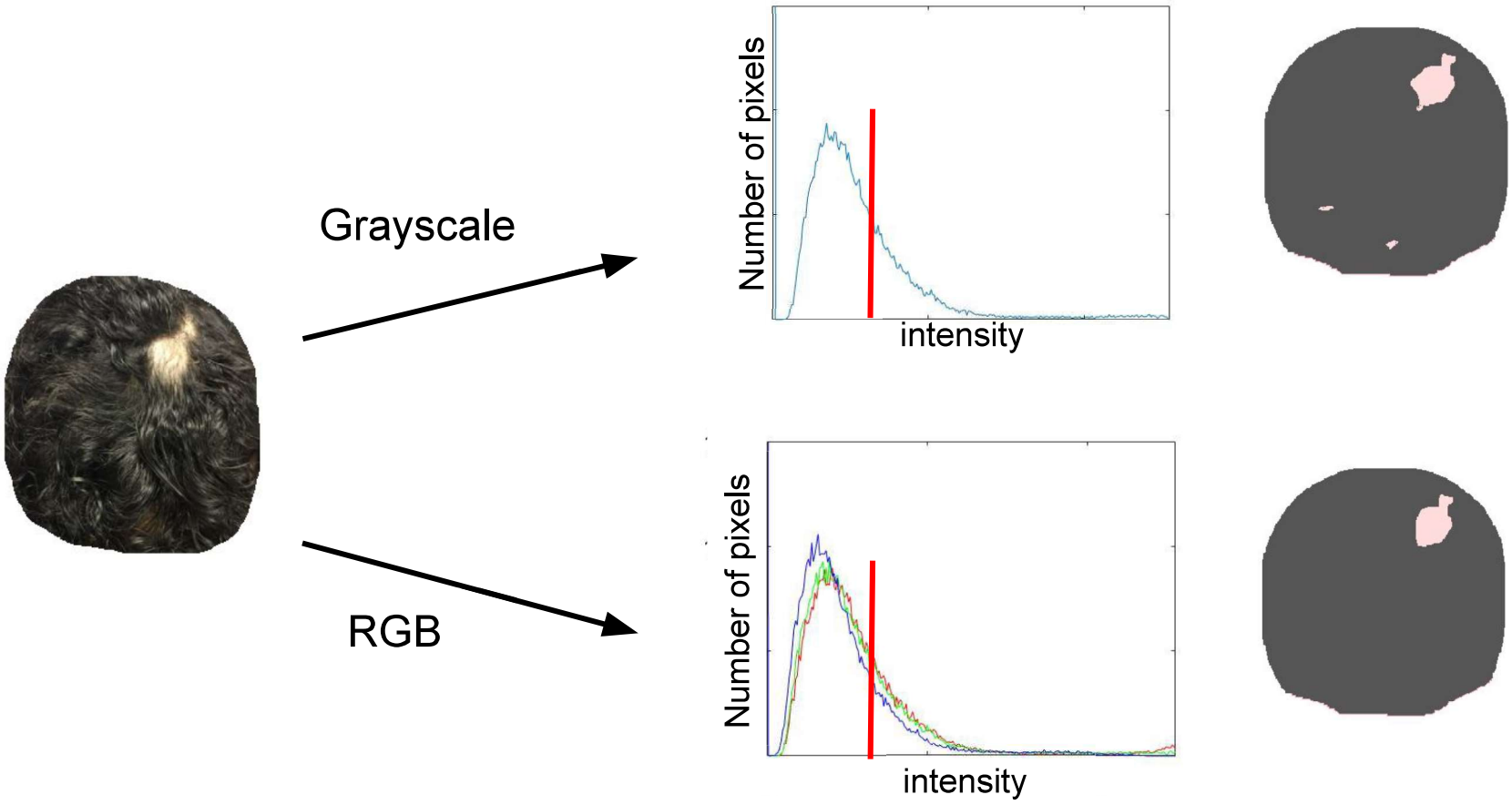
- Patch size: from *k* x *k* to the entire image
- Neighborhood Statistics: mean value, standard deviation, maximum/minimum value, intensity range



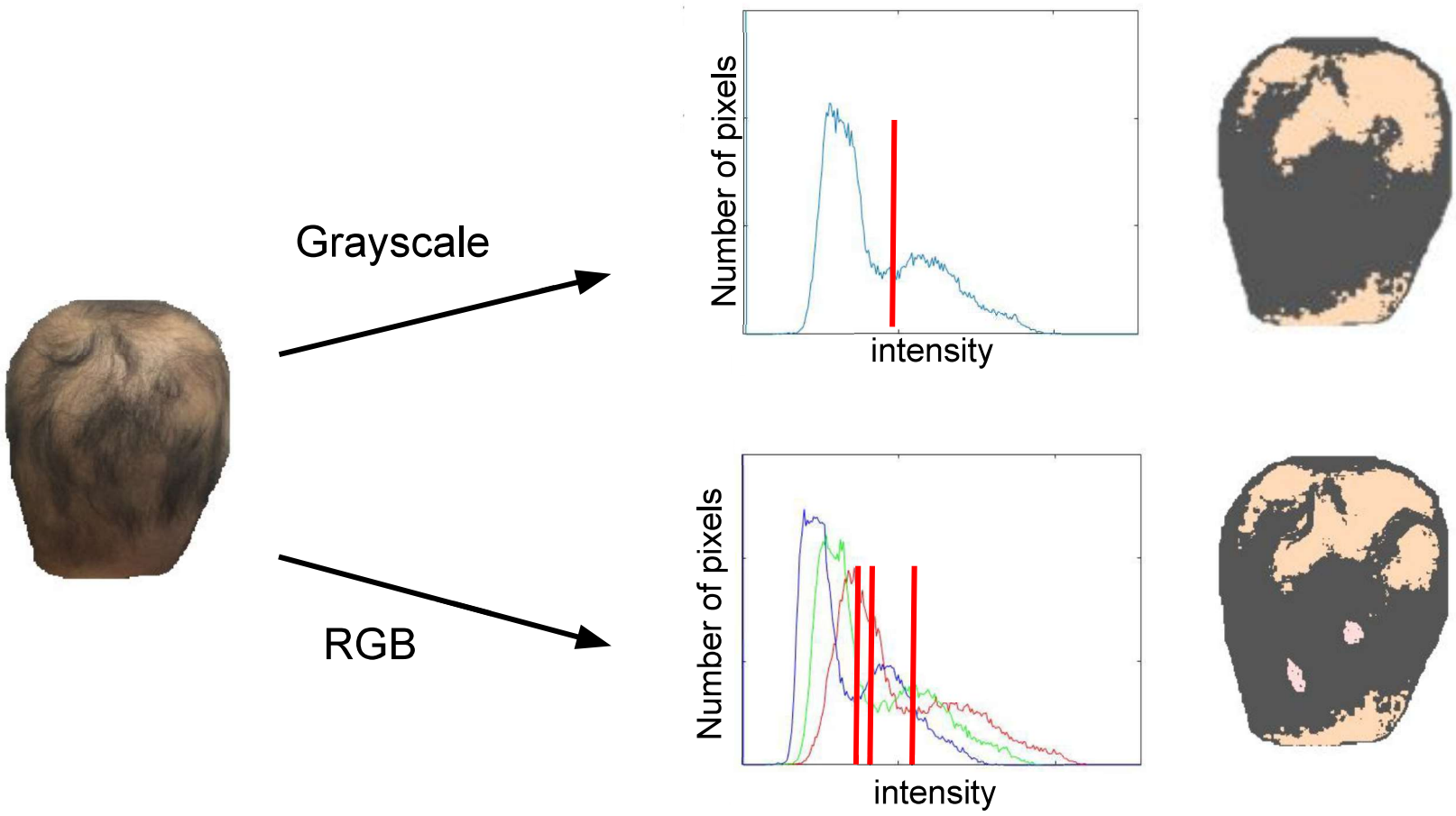
# Hair density segmentation

- Unsupervised
  - Histograms and thresholding
  - K-means
- Supervised
  - K-Nearest Neighbours (KNN)
  - Random Forests (RF)
  - Naive Bayes (NB)
  - Logistic Regression (LR)
  - Fully Connected Neural Networks (FCNN)

# Histograms and thresholding

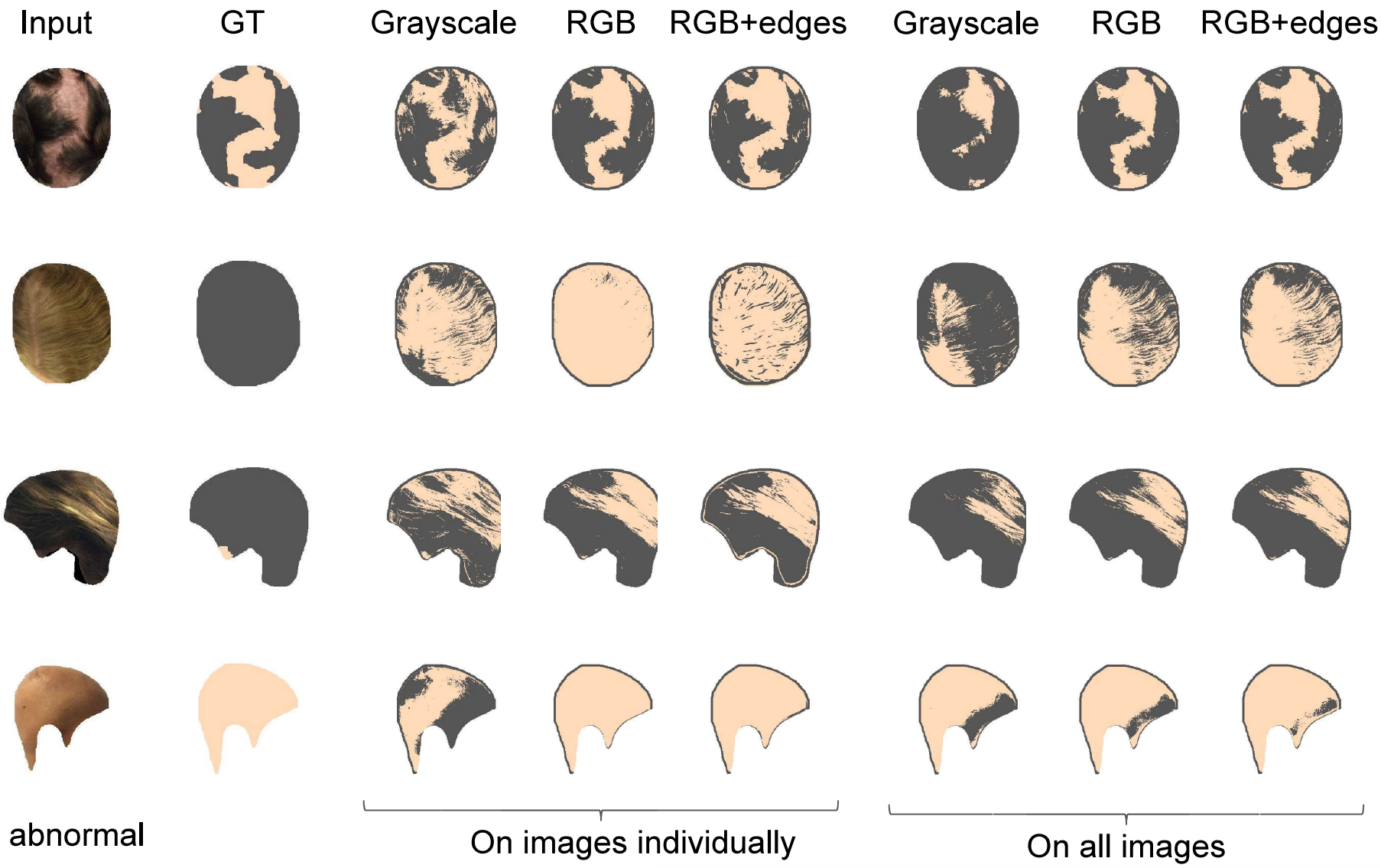


# Histograms and thresholding

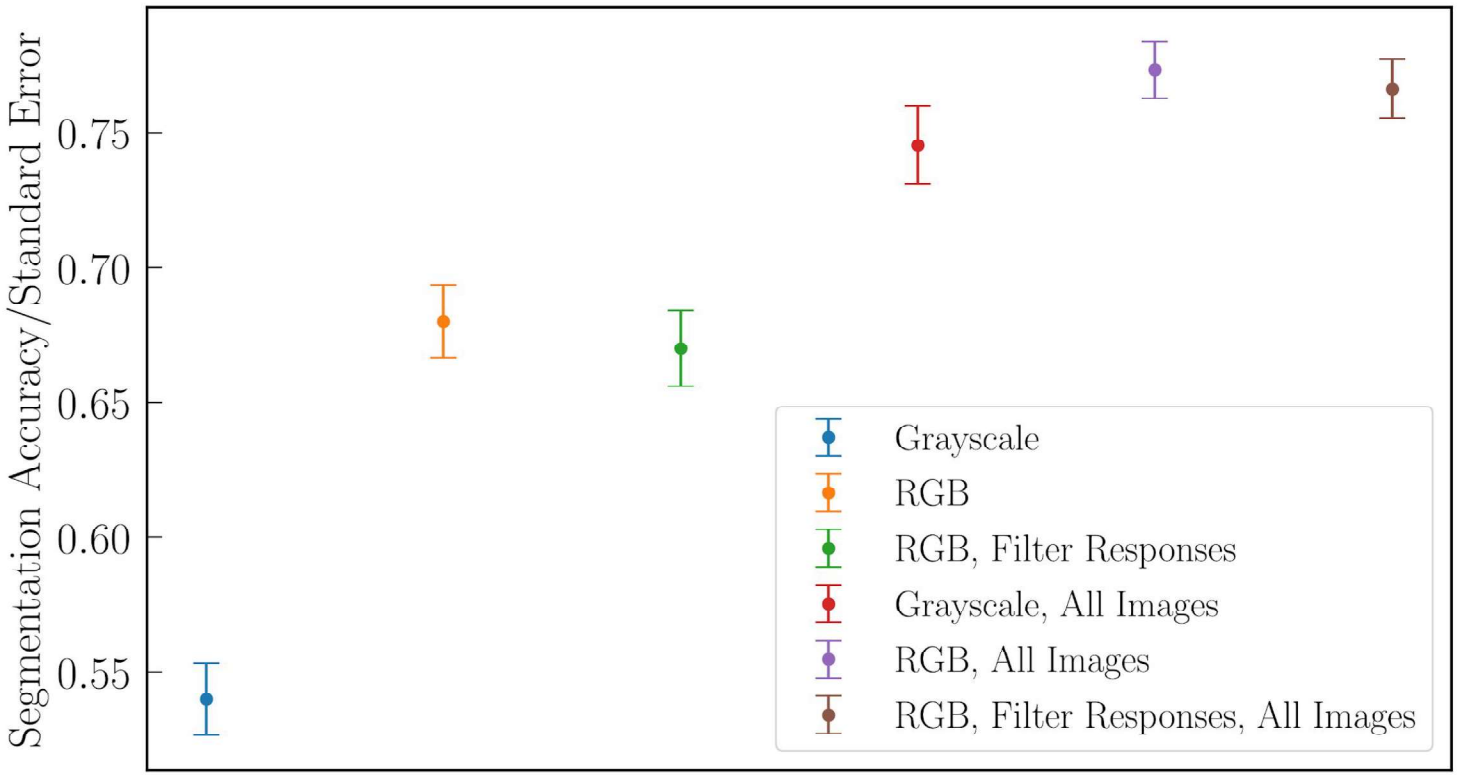



Even if we can find such thresholds, this method is not scalable.

# Sample segmentations by K-means



# Quantitative evaluation




$$\text{Segmentation Accuracy} = \frac{\#\text{ of correctly labelled pixels}}{\#\text{ of all pixels}}$$

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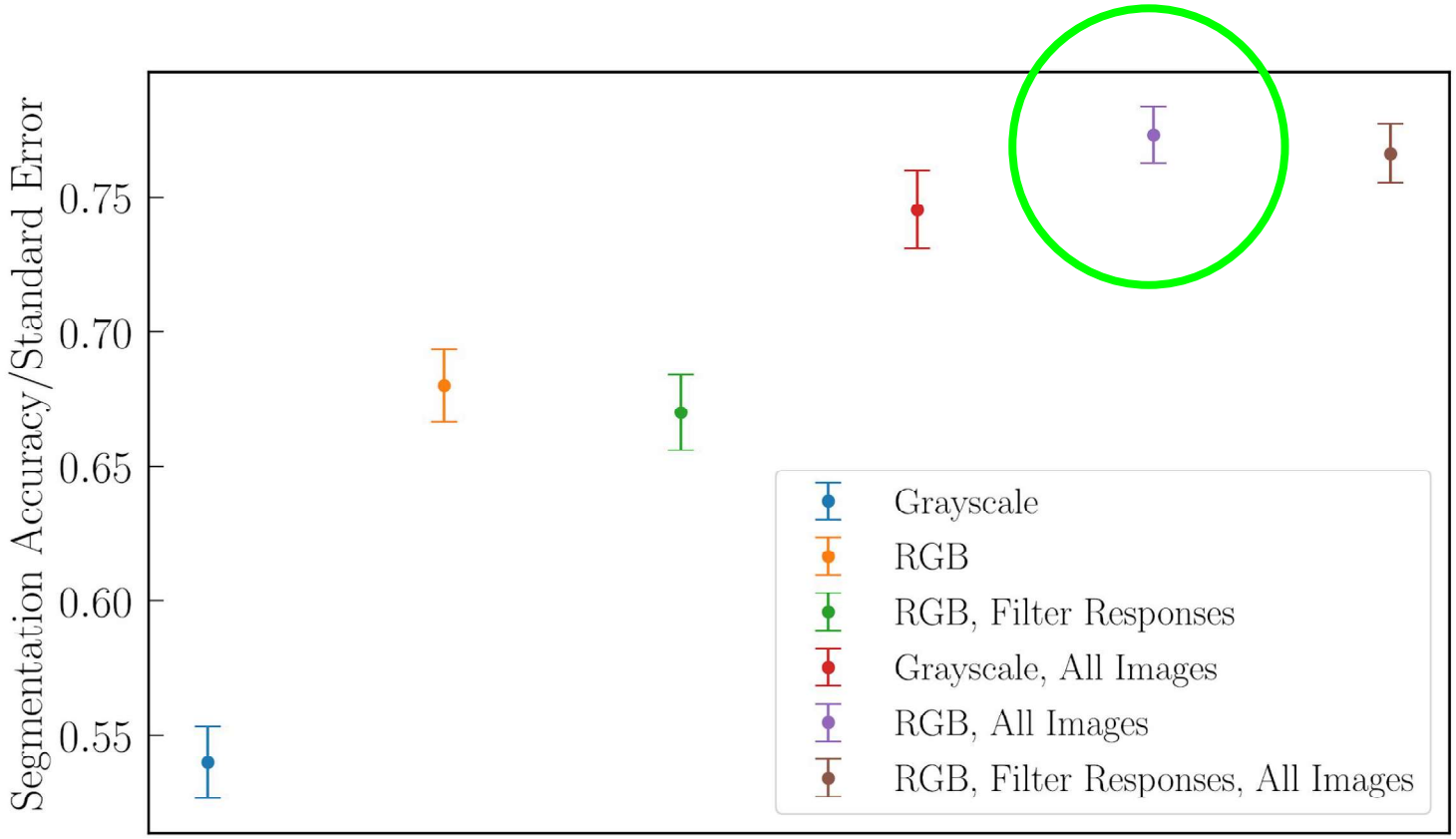


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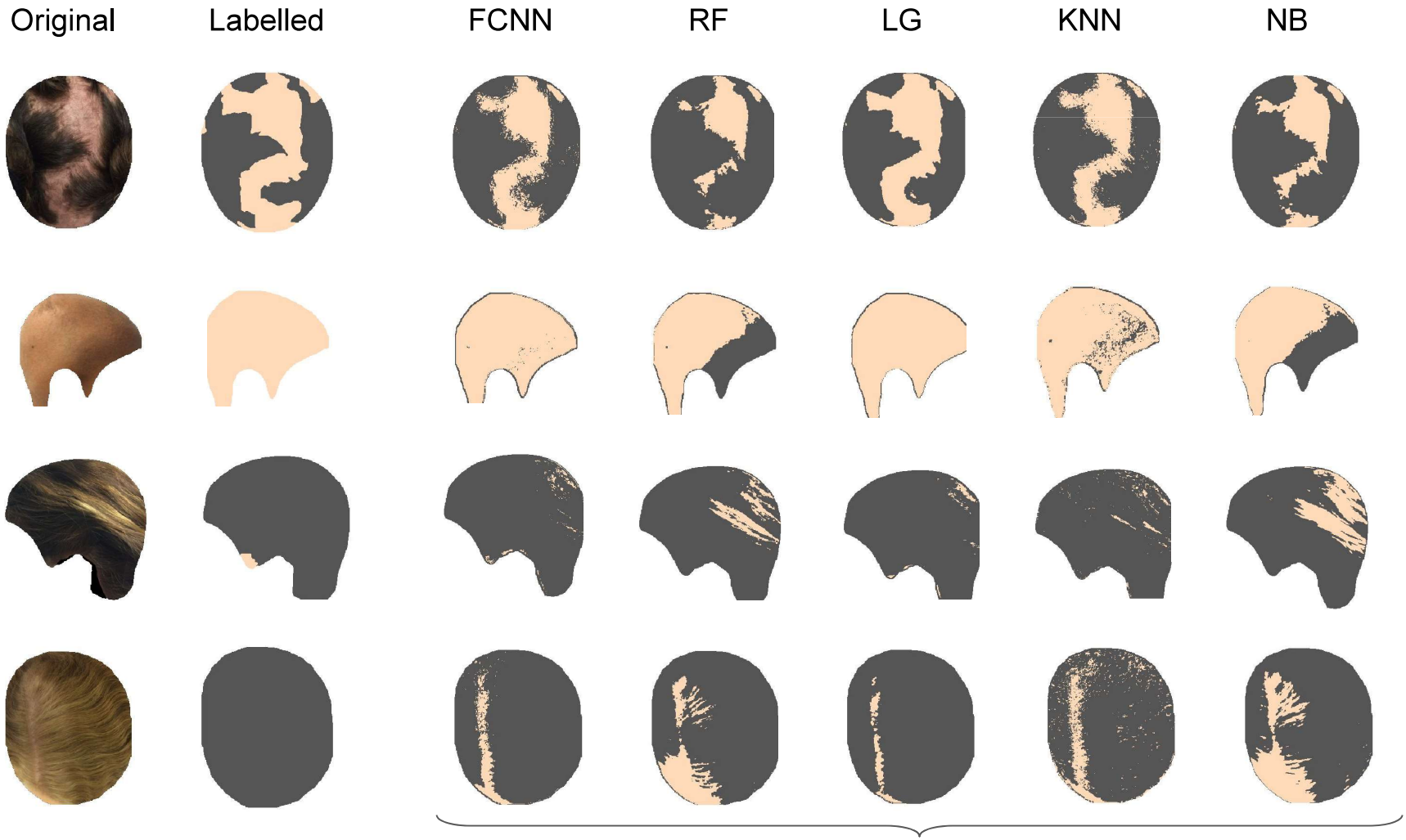
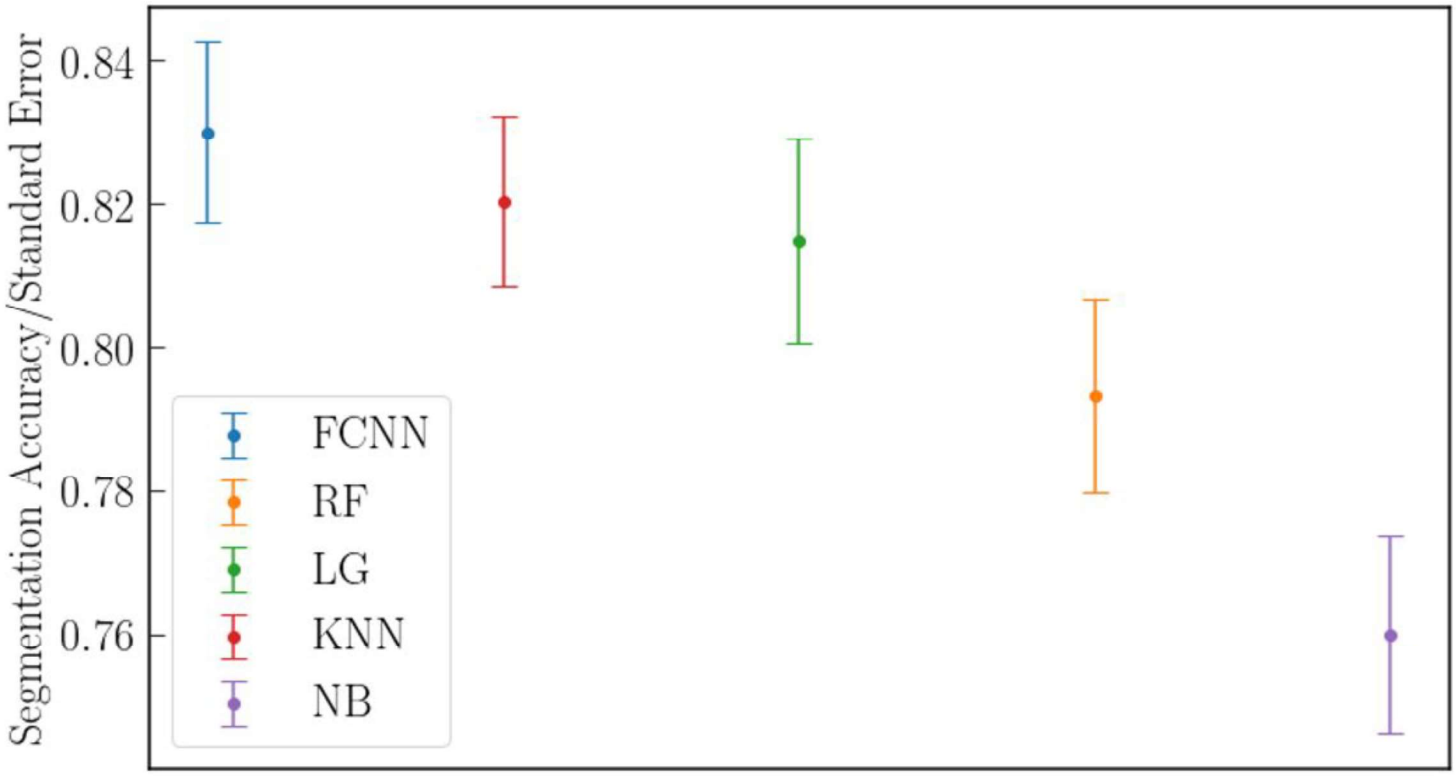
# Sample segmentations by ML algorithms



# Quantitative evaluation of ML models



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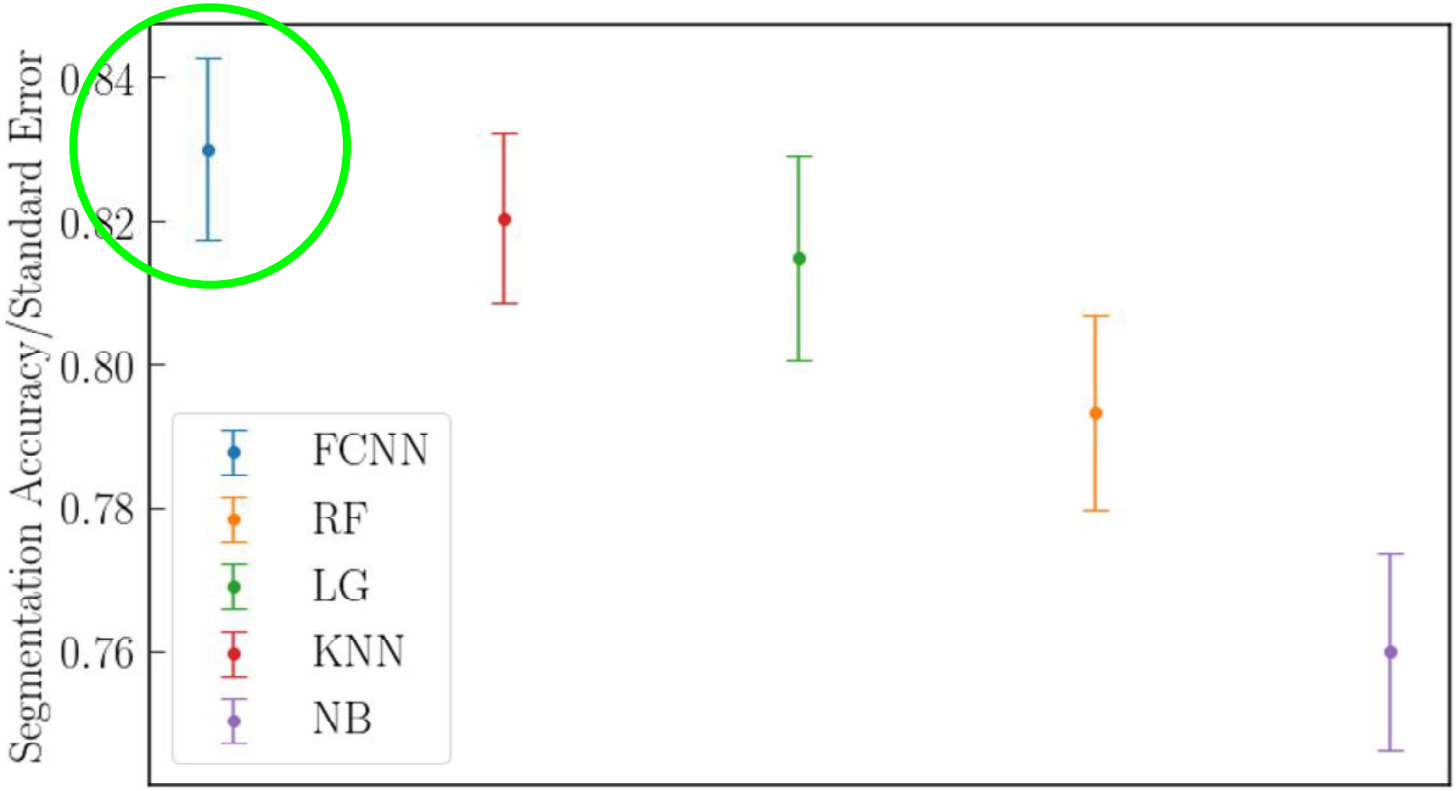

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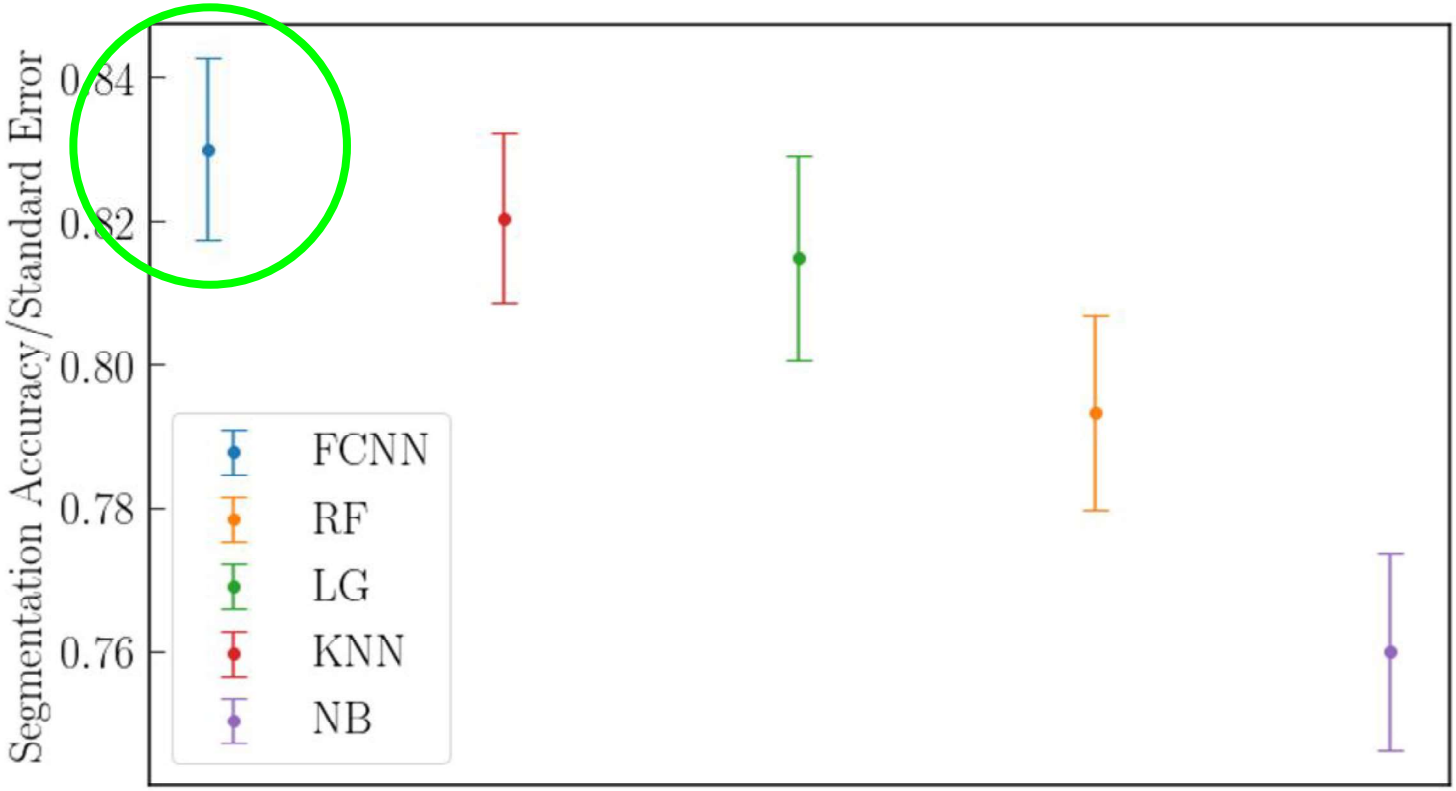
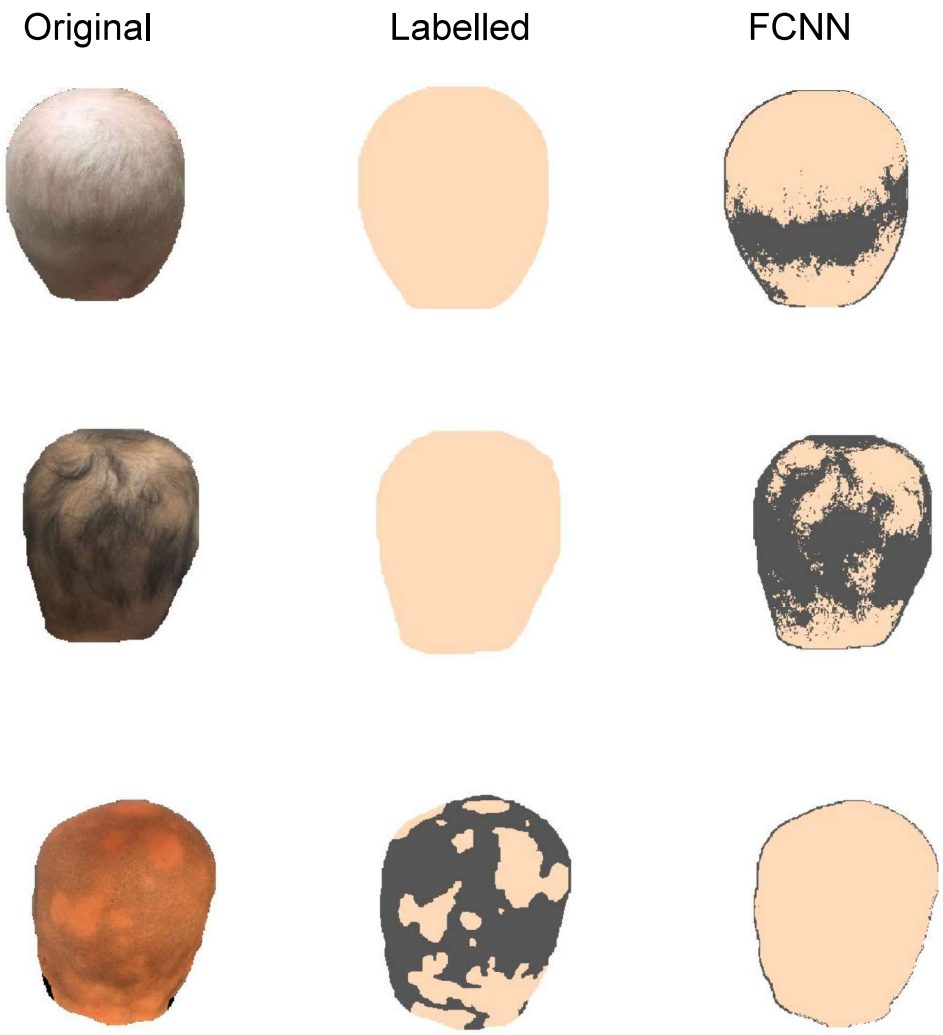



Note: >10% better than Appopecia app!

# Scope for improvement




abnormal density
normal density

# Conclusions: It was a hairy problem!

- Supervised preferred over unsupervised
- Visual/Clinical meaning of hair density regions

- Edges cannot be used to encode hair density information.
- Combining features is an art!

- RGB patches better than grayscale
- Hair color! Skin contrast!

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THANKS