Model Card Content: Hair Segmentation

Model Details

- A lightweight model to segment hair on a selfie image with one person captured by a smartphone camera. Returns a two class mask - hair/background.
- Developed by researchers at Google, 2019, version 2019-01-14.
- Encoder decoder network with skip connections (see description in https://ai.googleblog.com/2018/03/mobile-real-time-video-segmentation.html).
- Licensed under **Apache License, Version 2.0**.
- Please cite as: A. Tkachenka et al. Real-time Hair segmentation and recoloring on Mobile GPUs. CVPR Workshop on Computer Vision for Augmented and Virtual Reality, Long Beach, CA, USA, 2019.
- Project webpage: https://sites.google.com/corp/view/perception-cv4arvr/hair-segmentation .
- Example usage included as part of the open source MediaPipe example documentation hosted at http://github.com/google/mediapipe.

Intended Use

- The model is segments single person hair within images or videos captured by a smartphone camera.
- Intended to be used for mobile AR (augmented reality) applications.
- Not appropriate for human life-critical decisions. The primary intended application is entertainment.

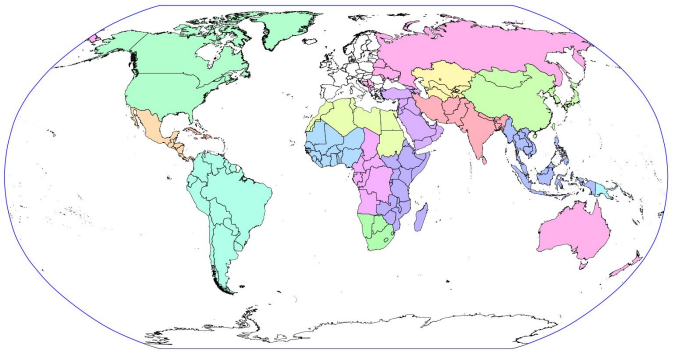
Limitations

- This model is made faster by being optimized for the use cases where the front-facing camera is used in “selfie” mode. As such, it is not suitable for people too far away from the camera (e.g. further than 5 feet/1.5 meters) or multiple people in an image.
- Hairstyles with thin and long pieces, such as mohawks and hairstyles with elongated braids, may not be reliably segmented
- Hair with any sort of large occlusion like headwear may not be reliably segmented
- Although the model has been trained and tested thoroughly across various “in-the-wild” smartphone camera conditions, including low-end devices, low light, motion blur etc., they can affect the performance characteristics.

Evaluation Dataset Disaggregating Factors

- **Geographical region of data capture**. Real-world frontal camera images have been captured in the following 17 geographic subregions (based on the UN geoscheme with merges and no EU countries):

Northern Africa	Caribbean	Central Asia	Australia and New Zealand
Eastern Africa	Central America	Eastern Asia	Europe (without EU)
Middle Africa	South America	South-eastern Asia	Melanesia, Micronesia, and Polynesia
Southern Africa	Northern America	Southern Asia	
Western Africa		Western Asia	



Metric

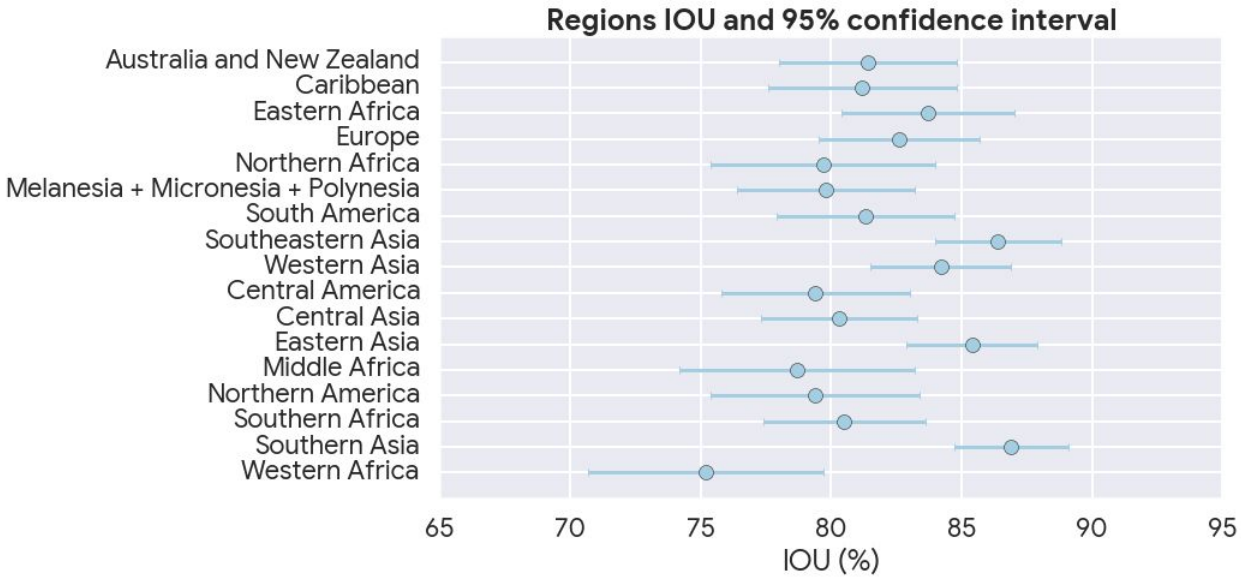
- **IOU, Intersection over Union**: A measure of similarity. In the segmentation case, the ratio between the area of intersection of two masks and the area covered by their union (also known as Jaccard Index https://en.wikipedia.org/wiki/Jaccard_index).
- Parity of this metric across subgroups serves as the indicator of "fairness" for this machine learning model.

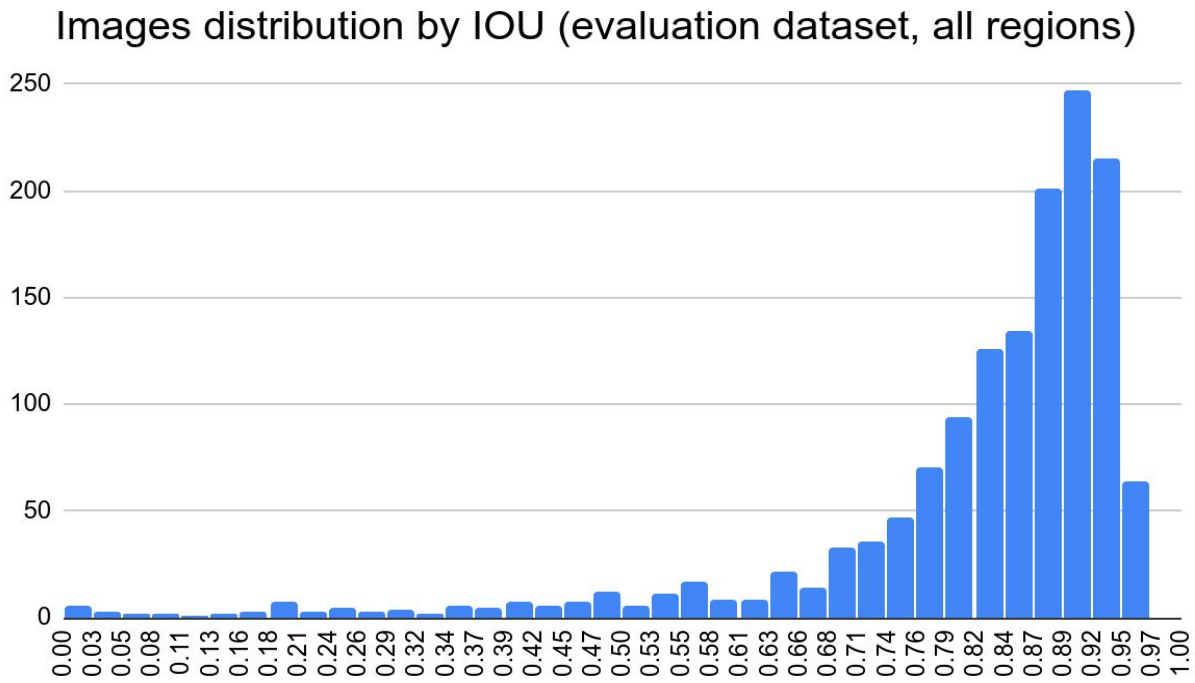
Evaluation Datasets

- 1445 images, 85 images from each of 17 the geographical subregions

Evaluation Results

Region	IOU	Standard deviation	95% confidence interval
Australia and New Zealand	81.4%	16.1%	81.4% ± 3.4%
Caribbean	81.2%	16.9%	81.2% ± 3.6%
Eastern Africa	83.7%	15.4%	83.7% ± 3.3%
Europe	82.6%	14.7%	82.6% ± 3.1%
Northern Africa	79.7%	20.1%	79.7% ± 4.3%
Melanesia + Micronesia + Polynesia	79.8%	16.2%	79.8% ± 3.4%
South America	81.3%	15.9%	81.3% ± 3.4%
Southeastern Asia	86.4%	11.1%	86.4% ± 2.4%
Western Asia	84.2%	12.5%	84.2% ± 2.7%
Central America	79.4%	17.0%	79.4% ± 3.6%
Central Asia	80.3%	13.9%	80.3% ± 3.0%
Eastern Asia	85.4%	11.7%	85.4% ± 2.5%
Middle Africa	78.7%	21.3%	78.7% ± 4.5%
Northern America	79.4%	18.7%	79.4% ± 4.0%
Southern Africa	80.5%	14.5%	80.5% ± 3.1%
Southern Asia	86.9%	10.5%	86.9% ± 2.2%
Western Africa	75.2%	21.3%	75.2% ± 4.5%
Total for all regions	**81.5%**	**16.3%**	**81.5% ± 0.8%**


Regions IOU and 95% confidence interval
Australia and New Zealand
Caribbean
Eastern Africa
Europe
Northern Africa
Melanesia + Micronesia + Polynesia
South America
Southeastern Asia
Western Asia
Central America
Central Asia
Eastern Asia
Middle Africa
Northern America
Southern Africa
Southern Asia
Western Africa
65
70
75
80
85
90
95
IOU (%)


Images distribution by IOU (evaluation dataset, all regions)
250
200
150
100
50
0
0.00
0.03
0.05
0.08
0.11
0.13
0.16
0.18
0.21
0.24
0.26
0.29
0.32
0.34
0.37
0.39
0.42
0.45
0.47
0.50
0.53
0.55
0.58
0.61
0.63
0.66
0.68
0.71
0.74
0.76
0.79
0.82
0.84
0.87
0.89
0.92
0.95
0.97
1.00