Does a Face Mask Protect my Privacy?: Deep Learning to Predict Protected Attributes from Masked Face Images

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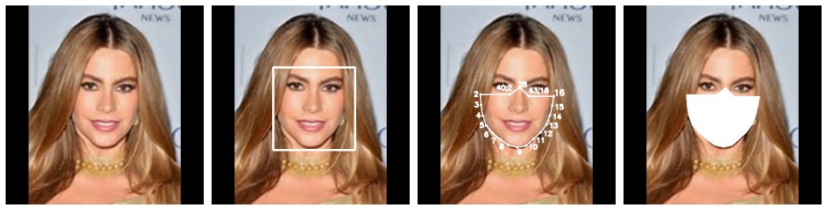
Abstract

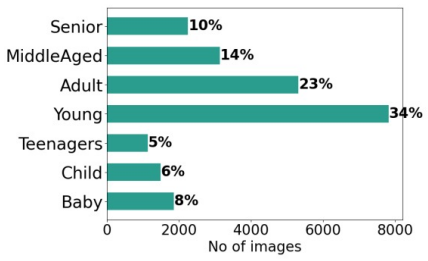
Contactless and efficient systems are implemented rapidly to advocate preventive methods in the fight against the COVID-19 pandemic. Despite the positive benefits of such systems, there is potential for exploitation by invading user privacy. We analyze the privacy invasiveness of face biometric systems by predicting privacy sensitive soft-biometrics using masked face images.

Data

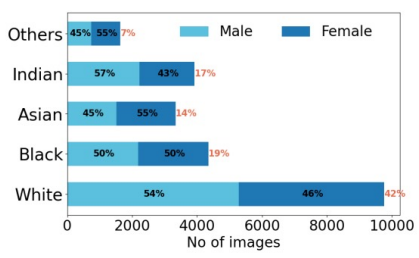
A synthetic mask generation process was implemented and used with the UTK faces dataset to create masked face dataset



(a) Original (b) Localization (c) Key points (d) Digital mask



(a) **Age distribution**



(b) **Race and gender distribution**

Methodology

A self-supervised representation learning step was used to initialize a masked facial representation, and then further specialized for protected attribute prediction.

This allows efficient construction of 4 downstream tasks (3 classification, 1 regression) across 2 different data splits.

Reproducible models, scripts and data can be found at: https://github.com/sachith500/MaskedFaceRepresentation

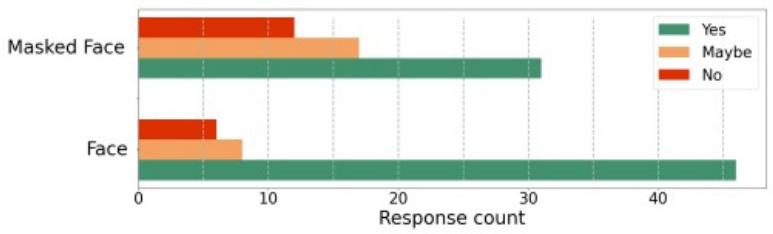
Privacy Vulnerability

The Privacy Vulnerability Index is used to quantify the privacy invasiveness of a biometric modality. This depends on

- Predictability of private attributes
- Importance of each attribute

Perceived privacy protection

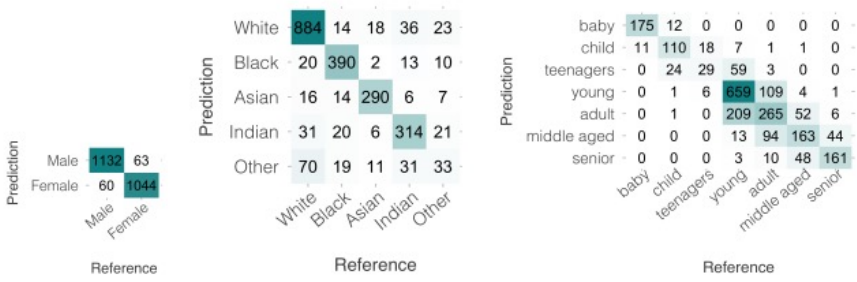
Our survey shows that the perceived privacy of wearing a mask is higher with statistical significance ($P = 0.00964 < 0.05$).



Results

Our models were able to predict sex, race and age to a level comparable to SOTA for unmasked face images

	Unmasked Face - SOTA	Masked Face (Random Split)	Masked Face (Uniform Split)
Sex	[13] **98.23%**	94.01%	**94.65%**
Race	[1] **91.23%**	82.20%	**83.12%**
Age (MAE) - Regression	[26] **5.44**	**6.21**	-
Age - Classification	[13] **70.1%**	-	**67.94%**



(a) **Sex** (b) **Race** (c) **Age**

As quantified by our analysis, the reduction in privacy invasiveness by wearing a mask is only 2.9%. This is very low compared to the 50% of people who thought that wearing a mask would be more private.