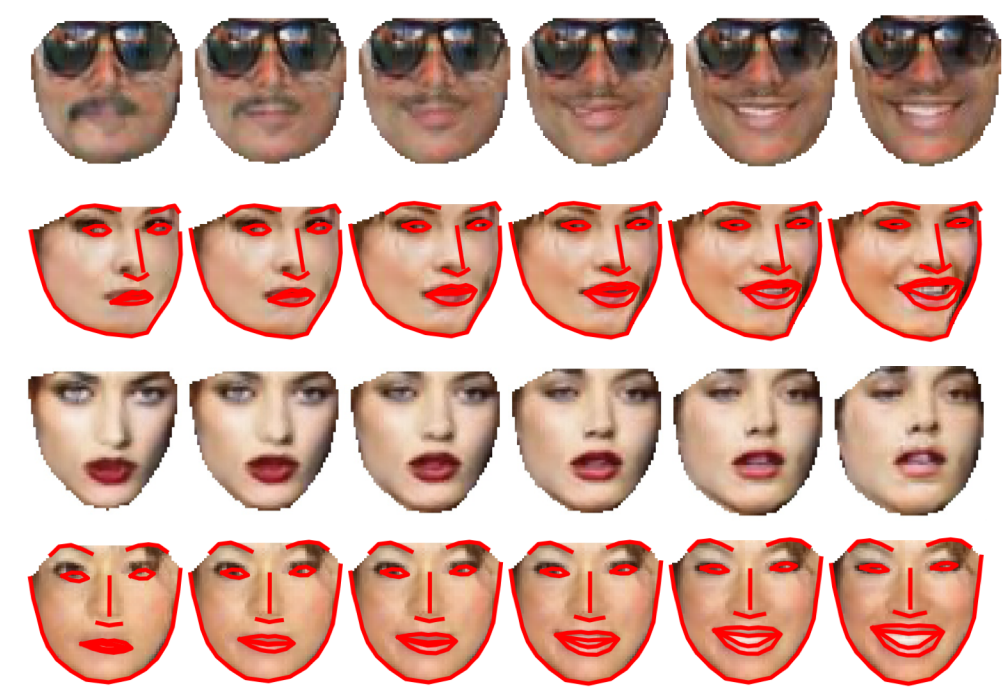




- Apart from the visual texture, the visual appearance of objects is significantly affected by their shape geometry, information which is not taken into account by existing generative models.
- Geometry-Aware Generative Adversarial Network (GAGAN) incorporate geometric information into the image generation process.
- The generator samples latent variables from the probability space of a statistical shape model.
- By mapping the output of the generator to a canonical coordinate frame through a differentiable geometric transformation, we enforce the geometry of the objects and add an implicit connection from the prior to the generated object



(a) Shape prior



(b) Appearance prior

## OBJECTIVE FUNCTION

$$\min_G \max_D V(D, G) = \mathbb{E}_{\tilde{\mathbf{I}} \sim P_{data}} [\log D(W(\tilde{\mathbf{I}}, \tilde{\mathbf{s}}))] + \mathbb{E}_{\tilde{\mathbf{z}} \sim \mathcal{N}(0, 1)} [\log(1 - D(W(G(\tilde{\mathbf{z}}), \tilde{\mathbf{s}})))] + \lambda \cdot LAP$$

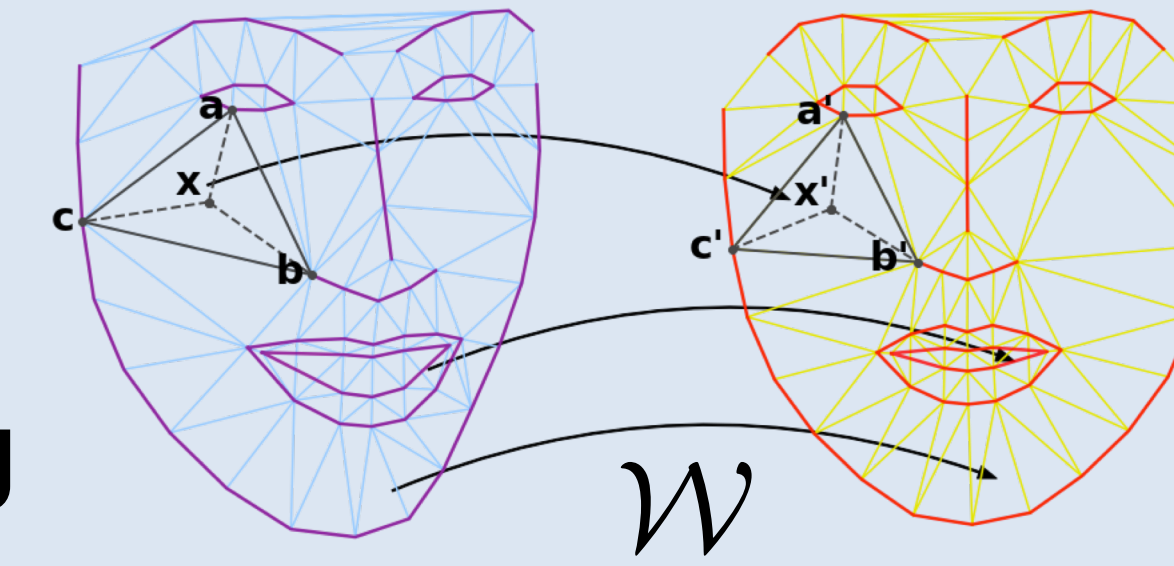
$$LAP = \ell_1 \left( \mathcal{W}(G(\tilde{\mathbf{z}}), \tilde{\mathbf{s}}), \mathcal{W}(G(\tilde{\mathbf{z}}_M), \tilde{\mathbf{s}}_M)) \right)$$

## STATISTICAL SHAPE MODEL

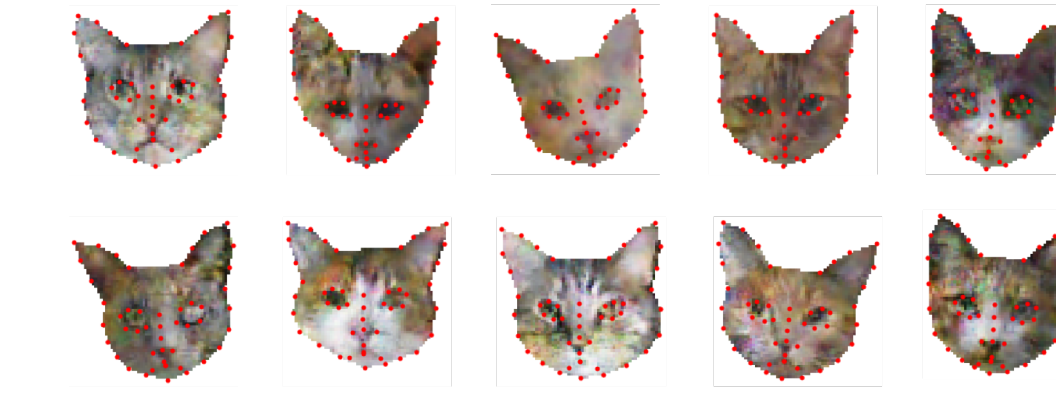
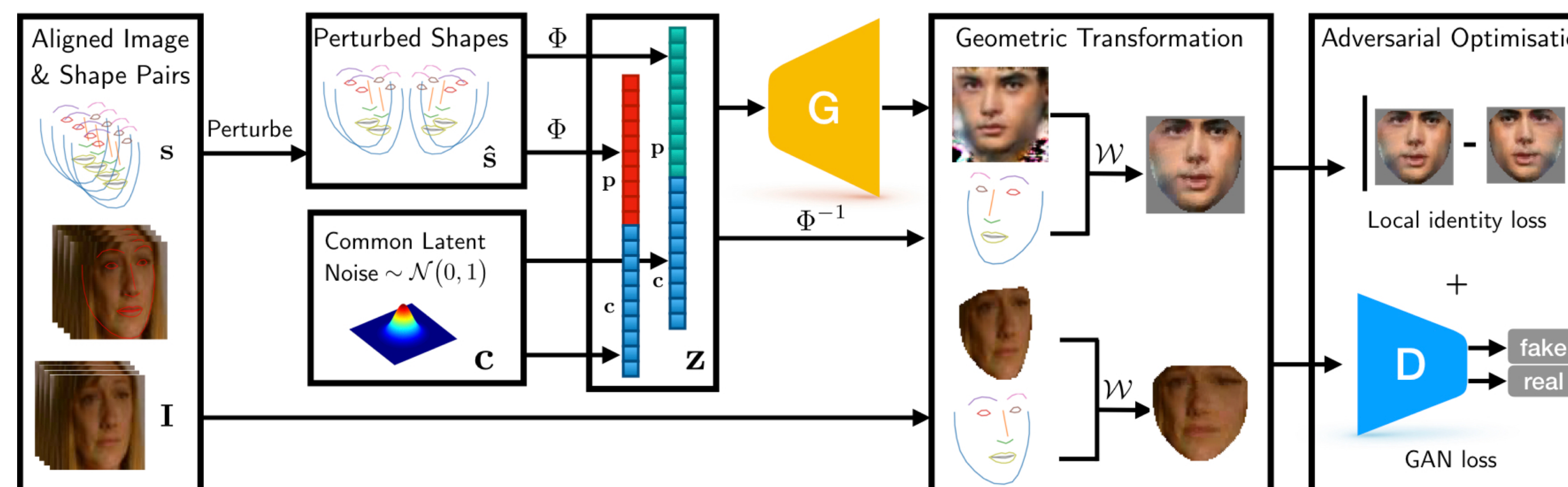
$$\mathbf{s} = \mathbf{s}_0 + \mathbf{S}\mathbf{p},$$

The Shape model is an efficient way to model the structure of the face. It is heavily used in Active Appearance Models (AAMs) for facial landmarks localization. The general idea is to represent the shape of a face a linear model, by applying PCA to a set of shapes, aligned using Generalized Procrustes Analysis.

## Enforcing the geometry: piecewise affine-warping

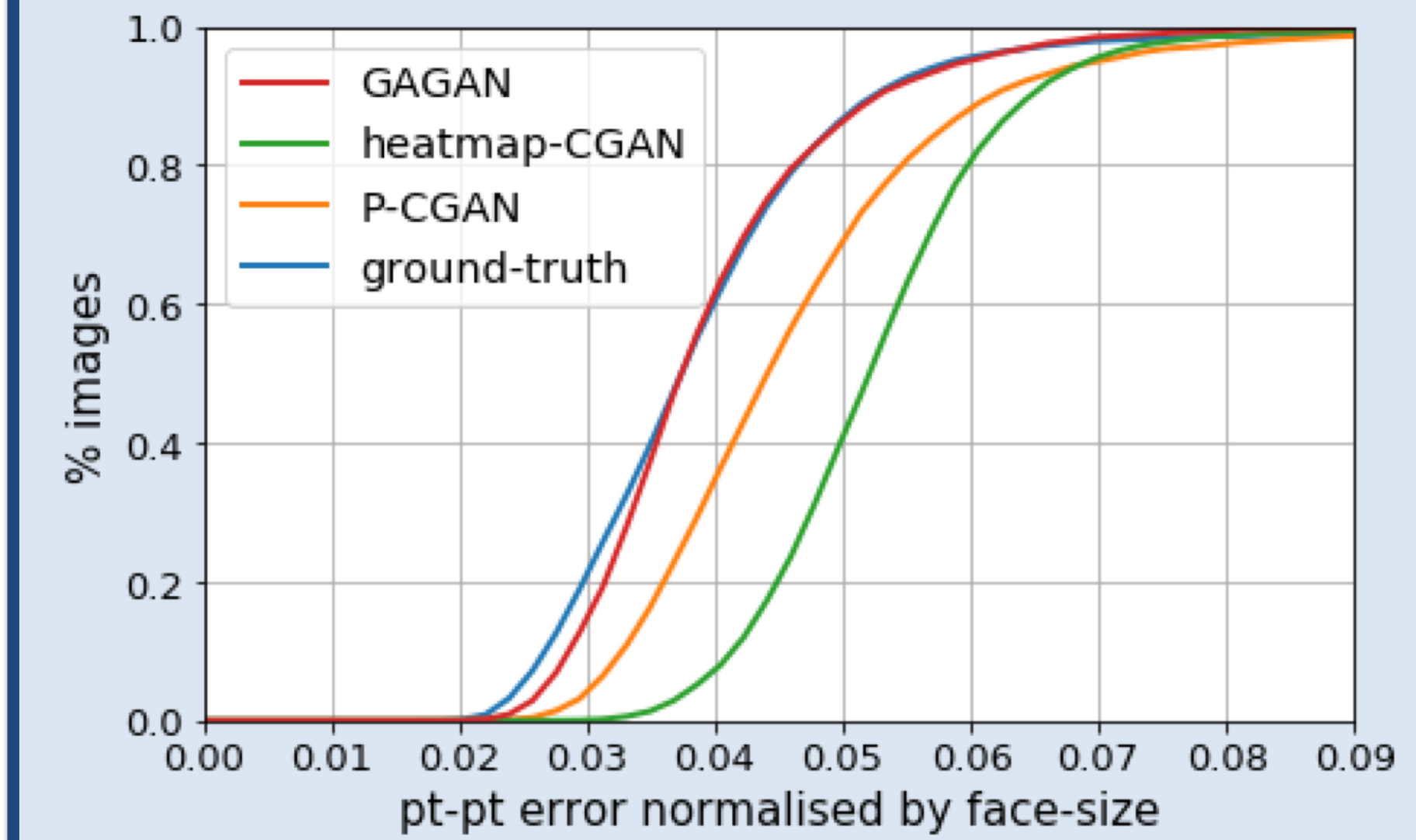


Also known as motion model in the AAM literature, the piecewise affine warping maps the pixels from any shape onto a canonical shape. The main advantage is that a set of object, for instance faces, in different poses and with different shape can be easily compared once mapped onto the canonical shape. This allows to also implicitly check whether the face is correctly aligned with the corresponding landmarks.



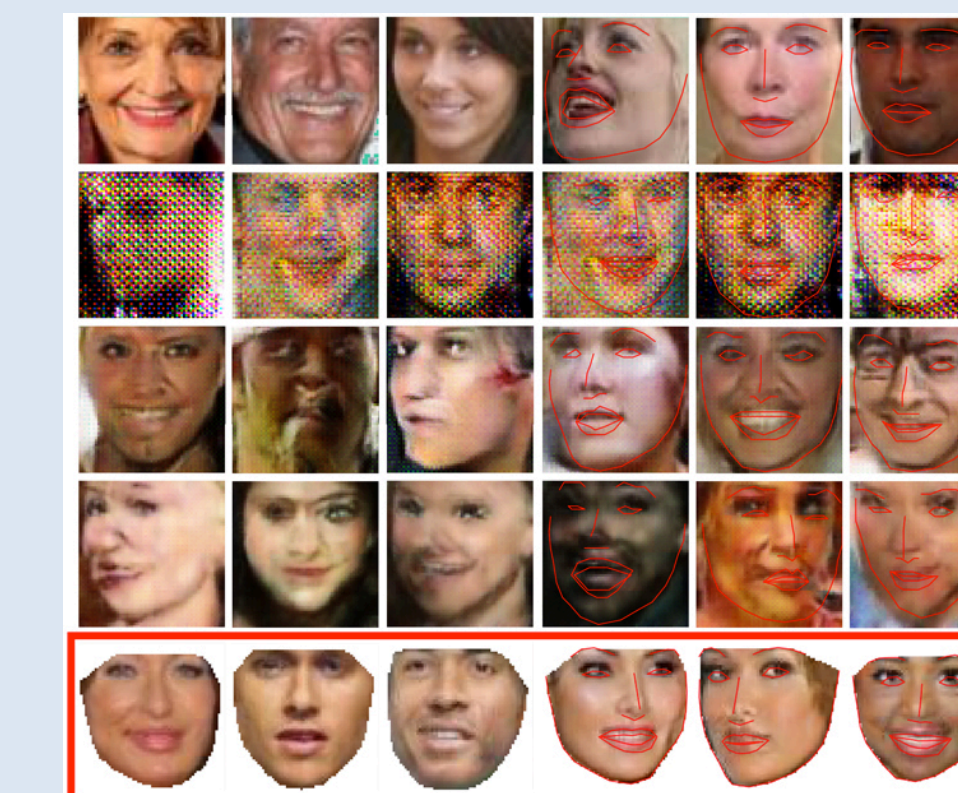
GAGAN works on small datasets (less than 400 images)

## PERFORMANCE



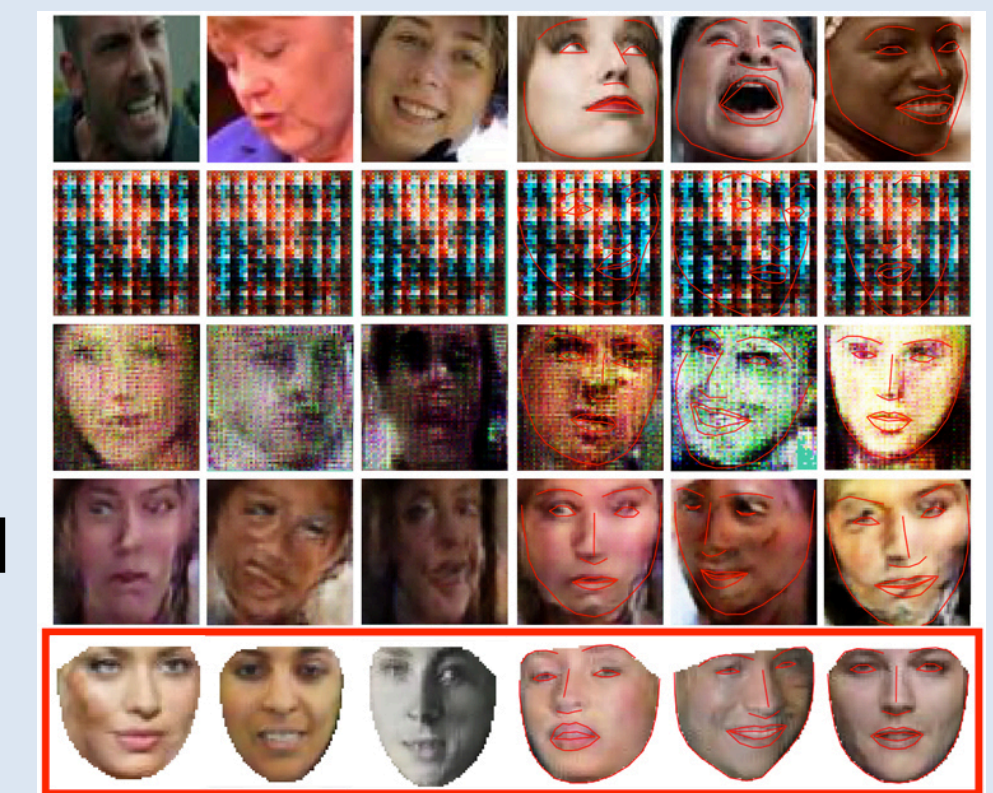
Error between the landmarks estimated by the detector and those used as prior to generate the images, all methods trained on CelebA. As a baseline, we evaluate the performance of the landmark detector on our GAGAN-small set (ground-truth, blue).

## Qualitative results



(a) Small set

Real images  
Shape-CGAN  
P-CGAN  
Heatmap-CGAN  
GAGAN



(b) CelebA