



Face Generation and Editing with StyleGAN^[1]

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[1] Melnik, A., et al. (2024). "Face generation and editing with stylegan: A survey." IEEE Transactions on Pattern Analysis and Machine Intelligence.

Questions

- ❖ **Have you ever used Generative AI? What are they?**
- ❖ **Have you used or heard of any of the following:**
 - **DALL·E 3 (by OpenAI)**
 - **Midjourney**
 - **Stable Diffusion**
 - **Sora (by OpenAI)**
- ❖ **Do you know what these Generative AI models have in common?**



Introduction to Generative AI models

Generative AI models: that learn to produce Synthetic Data (images, video, sound).
Two types of AI models dominate the image generative market

Diffusion Models

DALL·E 3, Midjourney, Stable Diffusion, Sora



Fig.1. DALL·E 3 example, developed by OpenAI

GANs Models

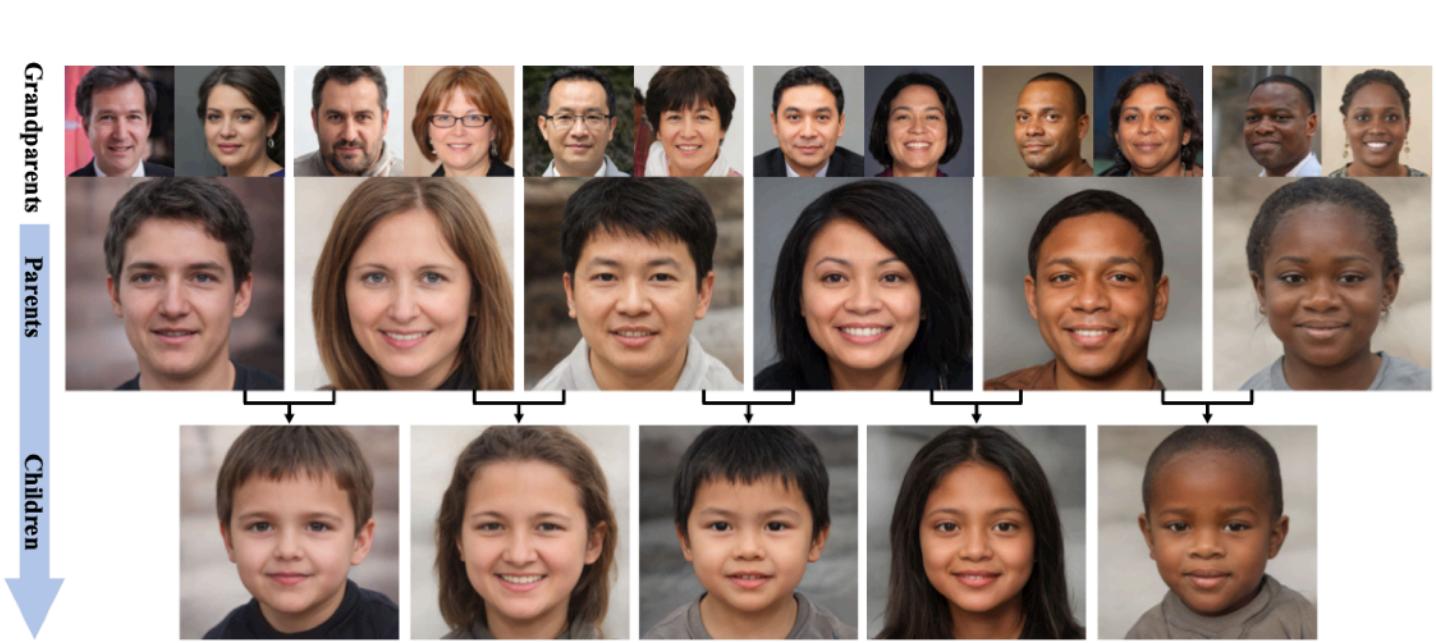


Fig.2. Synthetic kinship faces with resemblance to parents [2]

Content

- **State-of-the-Art Applications**
- **Architecture**
- **Latent Space**
- **Image Reconstruction & Manipulation**
- **Conclusion**



StyleGAN Applications



GANs was first introduced by Ian Goodfellow in 2014, inspiring the field of generative AI. GAN-based models have culminated in StyleGAN, developed by Nvidia in 2018.

What is the most important process of Generative AI models?

Training

- **Data Collection**
- **Model Training**
- **Optimisation**



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StyleGAN Applications

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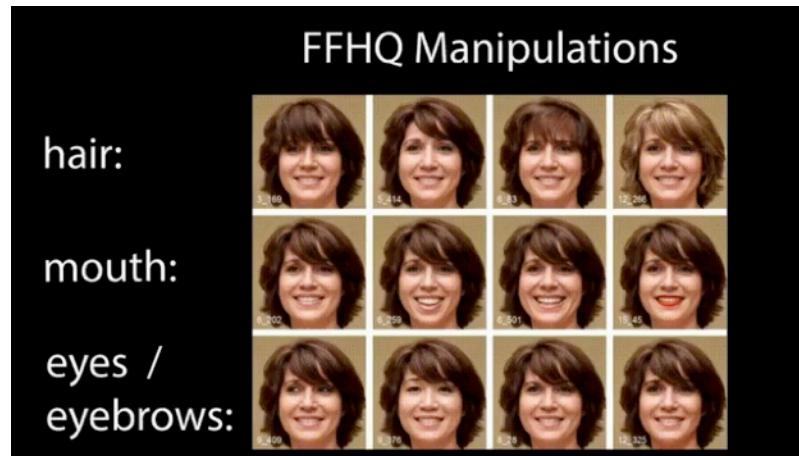
Synthetic Face Generation



Fig.3. FFHQ dataset example from StyleGAN2 [3]

‘This Person Does Not Exist’
this-person-does-not-exist.com

Editing Features



Facial Image Recovery

G. Blind Face Restoration



H. Identity Preserving Face Restoration



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Editing Features

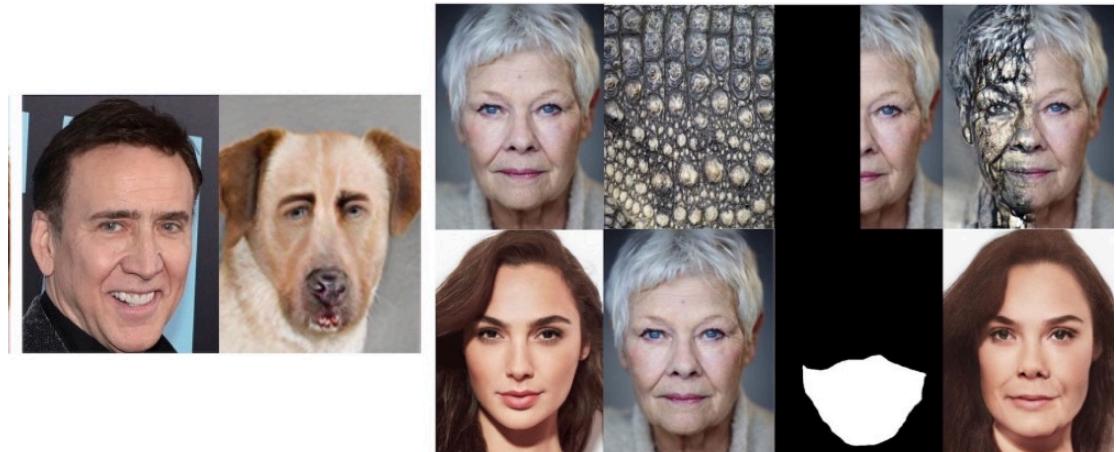


Fig.4. Face editing and image-crossover [4][5]

Facial Image Recovery

G. Blind Face Restoration



H. Identity Preserving Face Restoration



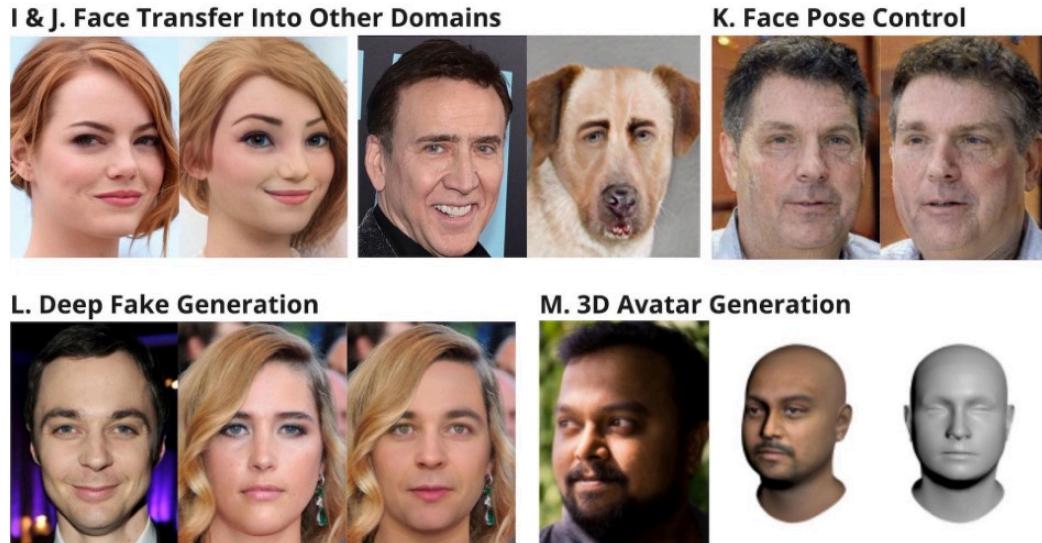
StyleGAN Applications

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Stylisation of Face

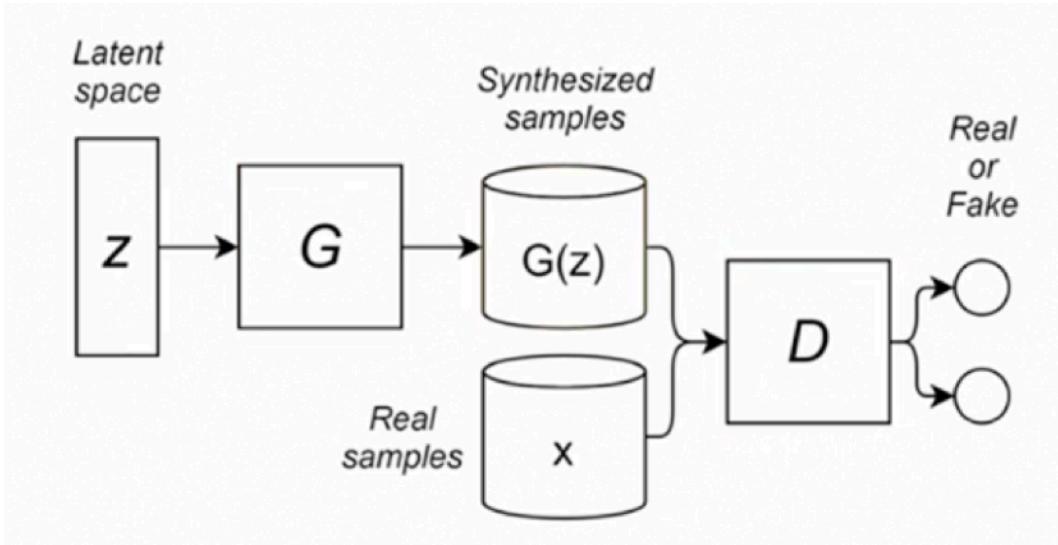


Other Examples



GANs Architecture

GANs architecture



Generative

- Creating new images from data

Adversarial

- Two models working together and against each other

Network

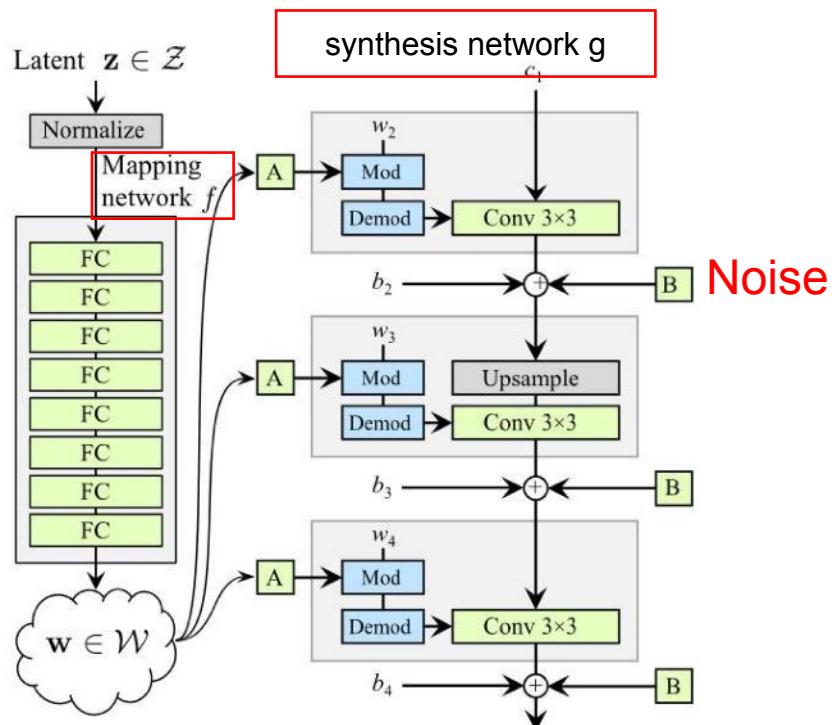
- Neural networks

GANs Training

- Traditional ML training occurs within both G&D model
- Each model learns how to work against the other

StyleGAN Architecture

StyleGAN architecture



Mapping Network f :

- maps a (normalised) latent vector z to an intermediate latent vector w .

Synthesis network g :

- to generate a "style" that controls the image synthesis process.

StyleGAN Latent Space

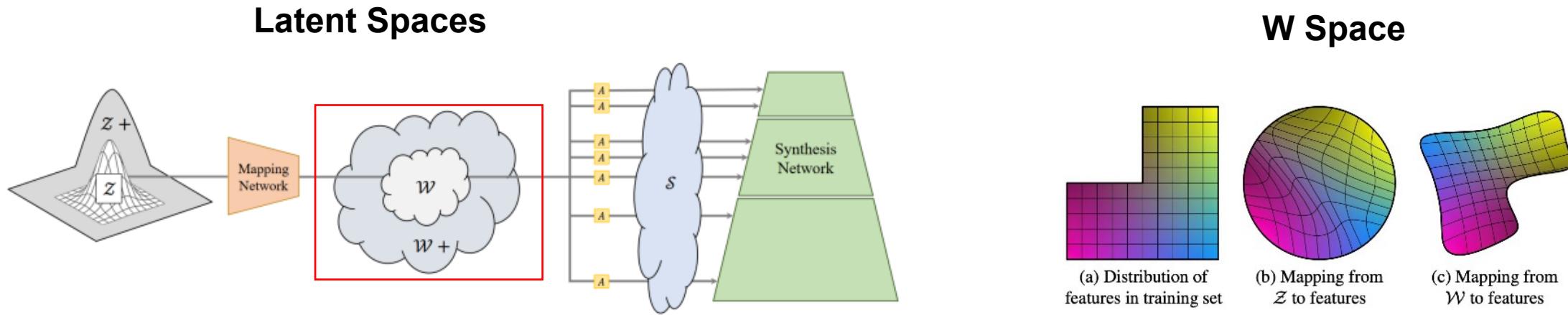
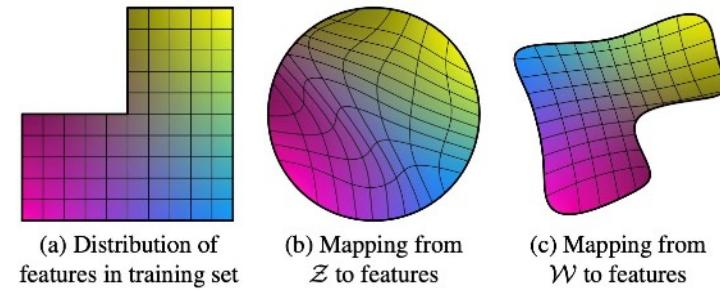


Fig.5. Latent spaces in StyleGAN.^[3]

- Unfold the disc-shaped \mathcal{Z} space into a space \mathcal{W} shape (right).
- Distort the simple \mathcal{Z} into a distribution \mathcal{W} of the same dimensionality of style parameters, requiring a non-linear mapping.



StyleGAN Latent Space

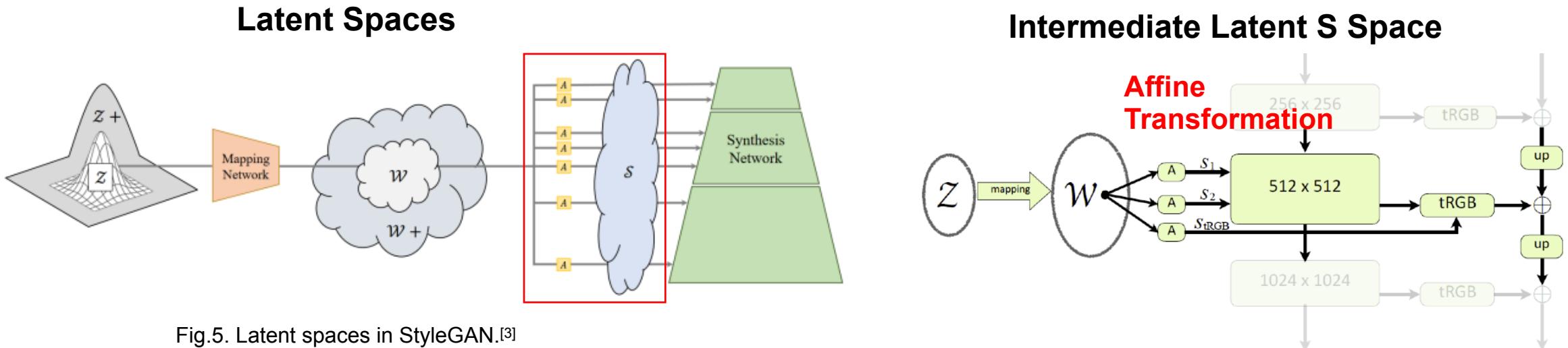
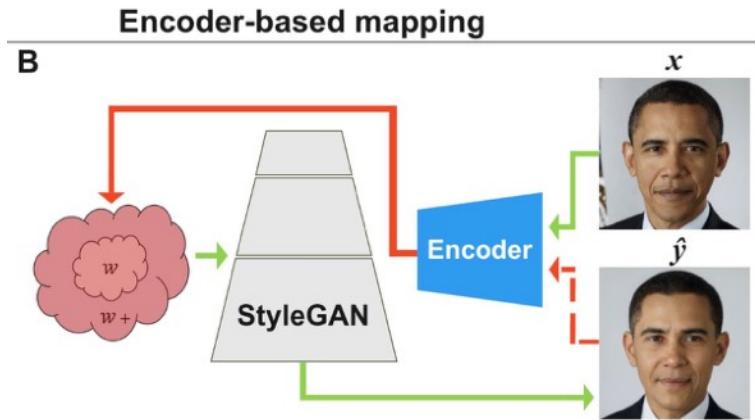


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Image Reconstruction and Manipulation

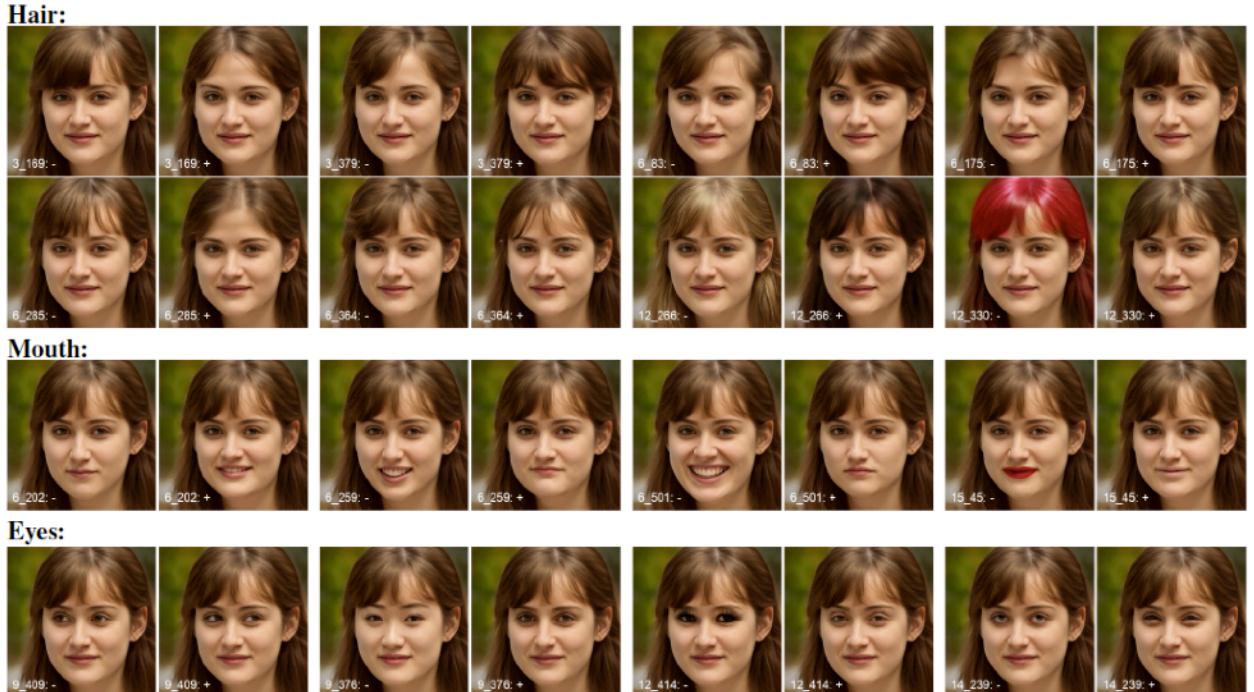
Reconstruction from Latent Spaces



Semantic Directions in \mathcal{W}



Semantic Directions in \mathcal{S}



Conclusion

- **Generative AI models**
 - GANs models & Diffusion models
- **State-of-the-Art Applications**
 - ‘This Person Does Not Exist’
 - kinship faces
 - Facial Image Recovery, etc.
- **Architecture**
 - GANs
 - StyleGAN
- **Latent Space: W, W+, S**
- **Image Reconstruction & Manipulation**



References

- [1] Melnik, A., et al. (2024). "Face generation and editing with stylegan: A survey." *IEEE Transactions on Pattern Analysis and Machine Intelligence*.
- [2] Li, H., et al. (2023). Stylegene: Crossover and mutation of region-level facial genes for kinship face synthesis. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition* (pp. 20960-20969).
- [3] Karras, T., et al. (2020). Analyzing and Improving the Image Quality of StyleGAN. 2020 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR).
- [4] Radford, A., Kim, J. W., Hallacy, C., Ramesh, A., Goh, G., Agarwal, S., ... & Sutskever, I. (2021, July). Learning transferable visual models from natural language supervision. In *International conference on machine learning* (pp. 8748-8763). PMLR.
- [5] Abdal, R., Qin, Y., & Wonka, P. (2020). Image2stylegan++: How to edit the embedded images?. In *Proceedings of the IEEE/CVF conference on computer vision and pattern recognition* (pp. 8296-8305).



Questions



Thanks for listening!

Q&A session



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