Morphix: Sculpt faces in real-time through latent space

Week 1: Introduction to GANs and StyleGAN2

Objectives

- Understand the fundamentals of GANs and StyleGAN2 architecture.

- Set up the development environment.

- Generate initial images using pre-trained StyleGAN2-ADA.

- Grasp the motivation for using latent space for facial edits.

Small Overview (Please refer to the papers given at the end for detailed understanding)

Understanding GANs and StyleGAN2

https://youtube.com/playlist?list=PLIoTHamoqkwsK7xVHMUP4_kCrsvvyBL5q&si=on_U0glL-1HI-Zyw
https://youtube.com/playlist?list=PLv8Cp2NvcY8AbK0RNZGeQFEPESqCzHQvj&si=N8BMlDA5JgURa3qb
https://youtube.com/playlist?list=PLjy4p-07OYzs6XDEm39m6g7yZWXB6MKac&si=bzxwZHaTMjSogaDx

---

Latent Spaces

https://youtu.be/iuQ_f3W5Ttk?si=yGA__kLejjooL95l
https://youtu.be/NtSsivniDKQ?si=Jmhba7Plez89DzNY

- **Z space**: input to the mapping network.

- **W space**: more disentangled; better for editing.

- **W+ space**: per-layer latent vectors; enables more precise edits.

Why Latent Space Editing?
Semantic attributes (e.g., age, expression) are encoded in directions in latent space.

Manipulating latent vectors → intuitive image edits.

Environment Setup

– Clone StyleGAN2-ADA Repo

```
git clone https://github.com/NVlabs/stylegan2-ada-pytorch.git
cd stylegan2-ada-pytorch
pip install -r requirements.txt
```

```
–Download Pre-trained Weights
# FFHQ (1024x1024 human faces)
wget https://nvlabs-fi-cdn.nvidia.com/stylegan2-ada-pytorch/pretrained/ffhq.pkl
```

Generate First Images

```
python generate.py --outdir=out --trunc=1 --seeds=2,12,42 --network=ffhq.pkl
```

--seeds: Different seeds generate different faces.

--trunc: Controls variability vs realism.

Resources:
– https://arxiv.org/pdf/1912.04958 Main paper behind StyleGAN2. Discusses architectural changes, path length regularization, and perceptual improvements.
– https://arxiv.org/pdf/1812.04948 Introduced the concept of style-based generation and intermediate latent space
– https://arxiv.org/abs/2005.09635 Explains how to find and use latent directions for meaningful semantic edits like age, smile, gender.
– https://arxiv.org/pdf/2004.02546 Introduces PCA-based latent space exploration for discovering interpretable edits (pose, lighting, etc.).
– https://github.com/NVlabs/stylegan2-ada-pytorch Official codebase with usage examples, pretrained models, and tools for image generation, training, and latent manipulation.
– https://github.com/nashory/gans-awesome-applications A curated list of GAN applications, models, and papers including StyleGAN, BigGAN, and many editing tools.

Week-2 resources

Understanding Z, W, and W+ Spaces

[Latent Space Exploration with StyleGAN2 | Epoching's Blog](#)

https://youtu.be/jKJCv9VGqLQ?si=jLtZ3MqS7NGzFi_n

Latent Vector Interpolation Techniques

[GitHub - woctezuma/stylegan2-projecting-images: Projecting images to latent space with StyleGAN2.](#)

Basic Attribute Manipulation

[GitHub - RameenAbdal/CLIP2StyleGAN: CLIP2StyleGAN: Unsupervised Extraction of StyleGAN Edit Directions (SIGGRAPH 2022)](#)

[2021-ICMLA.pdf](#)

Week 3

Objectives

- Learn about semantic latent directions
- Implement attribute manipulation (age, gender, expression)
- Understand disentanglement in latent space

  .

RESOURCES:

- Semantic latent directions
    - https://youtu.be/Ow8kKv8ely8?si=7EJ9Riz68BMMU8pR
    - https://youtu.be/iuQ_f3W5Ttk?si=zP5lthu9ScMmEChg
    - https://github.com/genforce/interfacegan

- Attribute Manipulations
    - https://github.com/JawadIshtiaq/Age-Gender-Detection

- Disentanglement in latent space
  - [ ] https://youtu.be/AwdPfcrFSmA?si=D8q-gLpetWfIdQ8M
  - [ ] https://github.com/harskish/ganspace
  - [ ] https://arxiv.org/abs/2005.07728

Week-5

Implement real-time **face sculpting** through direct manipulation of latent vectors.

Add **preset transformations** like hairstyles and accessories using learned semantic directions.

Ensure **real-time responsiveness** via model optimization and caching.

Add **save/load** functionality for latent edits.

Implement **undo/redo** stack for user actions.

Resources

GitHub - ziviland/stylegan2_latent_editor: Editor to change StyleGAN2 images manipulating latent W vector. Based on StyleFlow and GANSpace frameworks.

GitHub - genforce/interfacegan: [CVPR 2020] Interpreting the Latent Space of GANs for Semantic Face Editing

GitHub - harskish/ganspace: Discovering Interpretable GAN Controls [NeurIPS 2020]

GitHub - RameenAbdal/StyleFlow: StyleFlow: Attribute-conditioned Exploration of StyleGAN-generated Images using Conditional Continuous Normalizing Flows (ACM TOG 2021)

GitHub - orpatashnik/StyleCLIP: Official Implementation for "StyleCLIP: Text-Driven Manipulation of StyleGAN Imagery" (ICCV 2021 Oral)

numpy.save — NumPy v2.3 Manual

Week 6&7: Final Features and Optimization

Objectives:

Add advanced features (face blending, style mixing)

Resources:

[1912.04958] Analyzing and Improving the Image Quality of StyleGAN

StyleGAN2

https://learnopencv.com/face-morph-using-opencv-cpp-python/

GitHub - amirhb29/StyleGAN2_Style-Mixing: Using

stylegan2-ada/style_mixing.py at main · NVlabs/stylegan2-ada · GitHub