Weights2Weights++: Constructing the Weight Space for Customized Diffusion Models with VAE

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Introduction

Background: Recent methods like DreamBooth [2] can fine-tune diffusion models to only output images of a specific identity. [1] proposed to use PCA to build a latent space called Weights2Weights (*w2w*) from a set of weights of fine-tuned diffusion models. Users can manipulate, interpolate or sample weights from *w2w* space to generate new diffusion models which that encodes novel and consistent identifies.

Motivation: PCA is a *linear method* and may not capture the complex relationships between the weights. Our Insight is ***VAEs can be used to con -struct a more expressive, informative latent space.***

Task statement: Given a set of LoRA weights from different identity-specific diffusion models fine-tuned using DreamBooth [2], we aim to learn a latent space representation of the weights using a VAE.

Dataset: 60k+ fine-tuned LoRA weights used in [1].

Evaluation Metric: Quantitative comparison with [1] in *subject inversion* task using ID scores.

Method

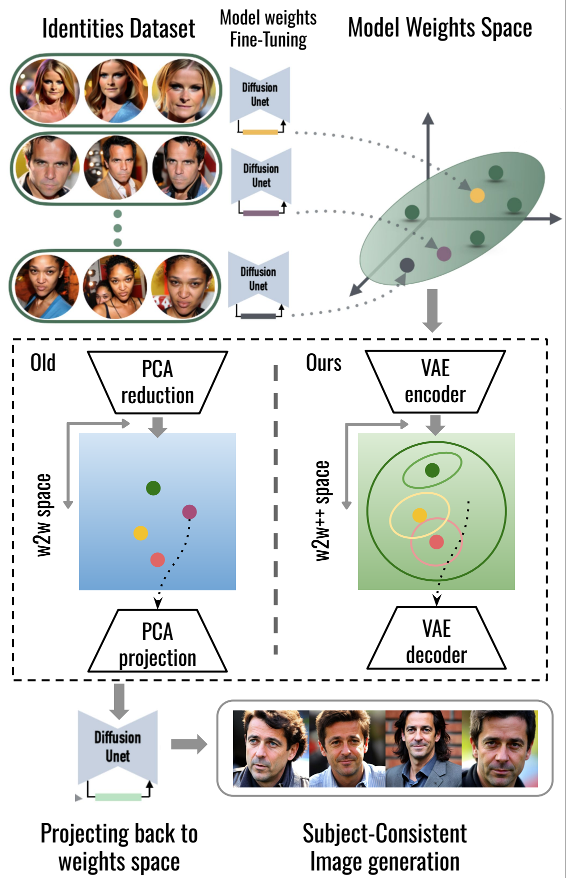
Construct weights manifold: [1] applies PCA on a LoRA weights dataset and models *w2w* as a linear combination of PCA bases. In comparison, we prop-ose to train a VAE model on the same dataset and use its latent space as *w2w++*.

W2W++ VAE: Encodes an 1-d weight vector into a latent distribution, then decodes model weights from samples drawn from this latent distribution. We apply KL Weight Annealing [3] to stabilize the training.

Downstream tasks benefited by *w2w++* space

- **Sampling:** Sample a latent vector from *N(0,I)* and pass it through the decoder, yielding a new model.
- **Interpolation**: Interpolation between two latent embeddings can blend two different subjects, resulting in fancy visualizations.
- **Subject Inversion:** Given an identity image, invert it into *w2w++* space. Motivated by [1], we fine-tune a diffusion model by only optimizing the latent vector that is passed into VAE decoder to generate the inverted model.

Pipeline



References

[1] Amil Dravid, Yossi Gandelsman, Kuan-Chieh Wang, Rameen Abdal, Gordon Wetzstein, Alexei A. Efros, and Kfir Aberman. Interpreting the Weight Space of Customized Diffusion Models. Advances in Neural Information Processing Systems (NeurIPS), 2024.

[2] Nataniel Ruiz, Yuanzhen Li, Varun Jampani, Yael Pritch, Michael Rubinstein, and Kfir Aberman. DreamBooth: Fine Tuning Text-to-Image Diffusion Models for Subject-Driven Generation. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), 2023.

[3] Samuel R. Bowman, Luke Vilnis, Oriol Vinyals, Andrew M. Dai, Rafal Jozefowicz, and Samy Bengio. Generating Sentences from a Continuous Space. arXiv preprint arXiv: 1511.06349, 2015.

Results

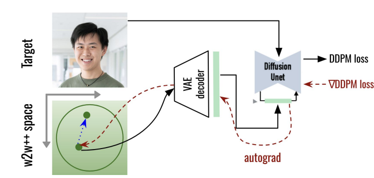
Reconstruction

Sampling

Interpolation

Baseline Inversion:

w2w++ Inversion:



Visualizing latent *w2w++* space