GAN Cocktail: mixing GANs without dataset access

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Problem Formulation:

- Given N GANs: $\{GAN_i = (G_i, D_i)\}_{i=1}^{N}$ where GAN_i was trained on $data_i$
- We aim to find $\text{UNIONGAN} = (G_u, D_u)$ s.t. $\forall_{c\in[N]} P_{G_u}(z, c) = P_{data_c}(x)$

Motivation:

- Generative adversarial networks (GANs) achieve impressive results but typically specialize on a specific image domain.
- This is in contrary to traditional computer graphics, where a general purpose representation and renderer can produce diverse object types and scenes.
- We explore model merging — the process in which two or more generative models are combined into a single conditional model. Thus creating a general purpose representation from specialized sub-models.

Advantages:

- Well suited for decentralized workflows.
- Reduce memory and computation requirements.
- Merged models enable semantic editing across domains.

Stage 1 - Model Rooting:

In order to use the weights of two pretrained models we need:

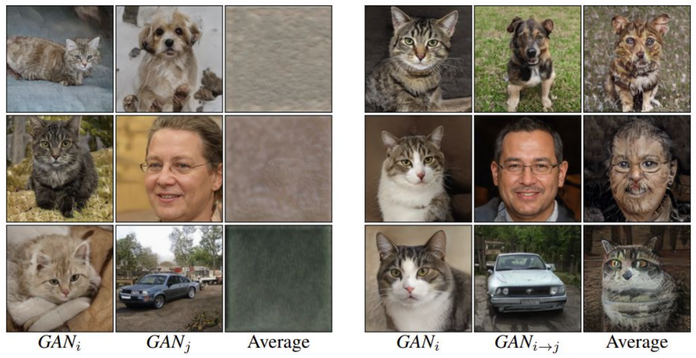
- The models to have the same architecture.
- The weights to have the same “semantic space”.

Inspiration:

- Exponential Weights Average (EWA) is a technique for averaging the model weights during the training process in order to merge several versions of the same model. Can be seen as an ensemble.
- EWA works because of a **shared common ancestor model.**

Stage 1 - Model Rooting (Cont.):

1. We choose one of the models to be the root model.
2. We train the rest of the models from the root model using the outputs of the source models.



Stage 2 - Model Merging:

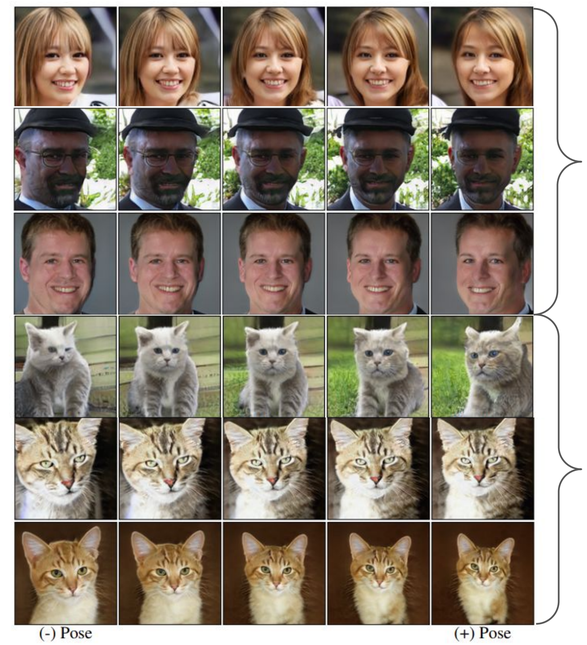
1. Create an average model:
   $GAN_a = (G_a, D_a)$ s.t. $\theta_a = \frac{1}{N}(\theta_r + \sum_{i\in[N]\setminus r} \theta_{r\to i})$
2. We train the rest of the models from the root model using the outputs of the source models.

Evaluation:

Datasets	FFHQ cat	cat dog	cat car	FFHQ cat dog	FFHQ cat dog car
From scratch	19.61	27.58	20.52	23.22	24.88
TransferGAN [38]	18.63	22.17	17.77	20.64	19.34
EWC [15]	19.45	22.17	17.65	19.47	19.14
Freeze-D [24]	18.17	21.92	17.52	19.71	19.41
Our	**16.44**	**20.77**	**16.85**	**18.98**	**18.44**

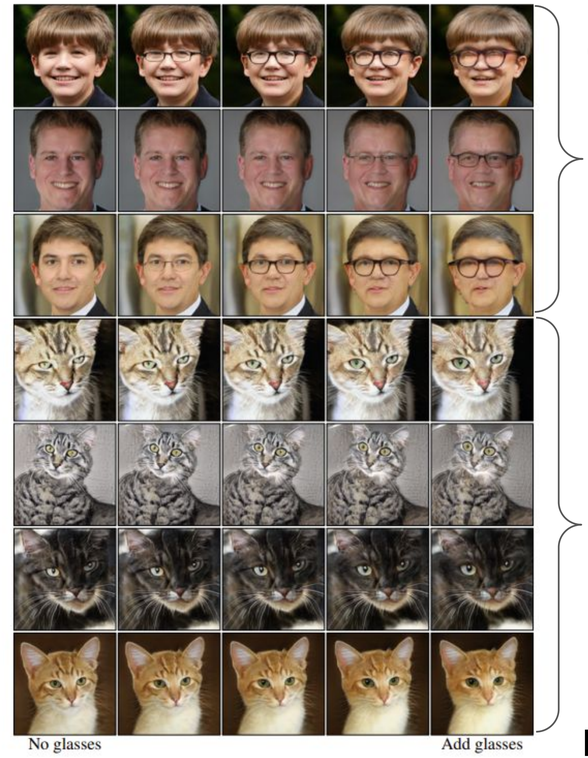
	LSUN cat+dog		LSUN cat+car		LSUN cat+FFHQ	
Dataset	cat	dog	cat	car	FFHQ	cat
Scratch	30.37	33.21	32.21	14.43	13.35	31.64
TransferGAN [38]	23.32	28.84	30.06	11.49	11.16	32.08
EWC [15]	23.04	30.11	30.65	**10.54**	**9.85**	35.36
Freeze-D [24]	23.36	28.40	29.78	11.44	10.64	31.57
Our	**22.08**	**26.52**	**27.78**	11.59	10.6	**27.82**

Semantic Editing:



Calculate the pose semantic direction using a pre-trained human classifier

The same calculated direction corresponds to the pose direction in the class of the cats



Calculate the glasses semantic direction using a pre-trained human classifier

The same calculated direction corresponds to the size of the eyes direction in the class of the cats

Project Page:
https://omriavrahami.com/GAN-cocktail-page/