Kernel Mean Matching for Content ADdressability of GANs

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Summary

- **Given**: Pre-trained GAN \( g \), input images \( X_m := \{x_i\}_{i=1}^n \)
- **Goal**: Generate images \( Y_n := \{y_j\}_{j=1}^n \) similar to \( X_m \).
- **Propose CADGAN**: a kernel mean matching procedure that adds "content-addressability" to \( g \) at run-time.
- **Advantages**:
  1. No need to retrain \( g \).
  2. Flexible choice of the similarity criterion.
  3. Fine-grained control with input weights \( \{w_i\}_{i=1}^n \).

Proposal: CADGAN

**CADGAN**: Generate images from \( g \) so as to match the mean feature of the input images represented in a reproducing kernel Hilbert space (RKHS).

Kernel Mean Matching with a Generator

- Let \( K(a, b) = \langle \phi(a), \phi(b) \rangle_H \) be a kernel (\( \approx \) similarity) between two images \( a, b \).
- Parametrize \( y_j = g(z_j) \) where \( z_j \) is a latent vector.
- Then, (1) can be rewritten as
  \[
  \min \sum_{i,j=1}^m w_i w_j K(x_i, x_j) + \frac{1}{n} \sum_{i,j=1}^n K(g(z_i), g(z_j)) - \frac{2}{n} \sum_{i,j=1}^m w_i \sum_{j=1}^n K(x_i, g(z_j)).
  \]

Proposed CADGAN: \( \arg \min_{z_j} (2) \)

- Optimize the latent vectors \( \{z_j\}_{j=1}^n \) with Adam.
- Output images: \( \{g(z_j)\}_{j=1}^n \).
- Use kernel \( K(a, b) = k(E(a), E(b)) \) where \( E \) is an image feature extractor of choice e.g., VGG Face, Places365-ResNet.
- Use IMQ kernel \( k(a, t) = (c^2 + ||a-t||^2)^{-1/2} \) for some \( c > 0 \).

Experiment: CelebA-HQ

- \( g = \text{GAN from Mescheder et al., 2018 trained on CelebA-HQ} \).
- For each \( (w_1, w_2, w_3) \), generate \( n = 1 \) image from \( m = 3 \) input images.

Experiment: LSUN-{Bridge, Bedroom, Tower}

- Unconditional samples from \( g \)
- Set \( E = \text{color extractor} \)
- Set \( E = \text{digit classifier} \)

Experiment: Flexible Choice of Similarity Criterion

Aspects of the input image(s) that will be captured can be controlled by changing the extractor \( E \).

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Code: https://github.com/wittawatj/cadgan