MIT-CSAIL

Theme(s) : GANs, coevolution, diversity
Team: **Anyscale Learning for All (ALFA)**
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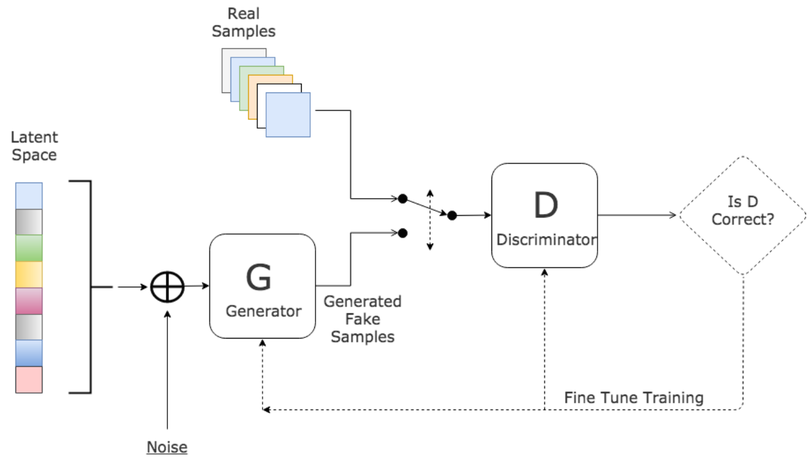
Title: **Fostering Diversity in Generative Adversarial Networks Coevolutionary Training**

Abstract: We propose the Mustangs training designed to foster diversity during the training process. Mustangs uses a spatial distributed coevolutionary competitive algorithm to evolve two populations of discriminators and generators on a spatial grid. For each iteration, each network randomly picks a loss function to optimize its weights according to different objectives to increase the diversity.

Motivation

Generative Adversarial Networks



$$\min_{\mathcal{G}} \max_{\mathcal{D}} \mathcal{L}(\mathcal{D}, \mathcal{G}) = \mathbb{E}_{x \sim p_{data}(x)}[\phi(\mathcal{D}(x))] + \mathbb{E}_{x \sim p_z(z)}[\phi(1 - \mathcal{D}(\mathcal{G}(z)))]$$

Proposal Highlights

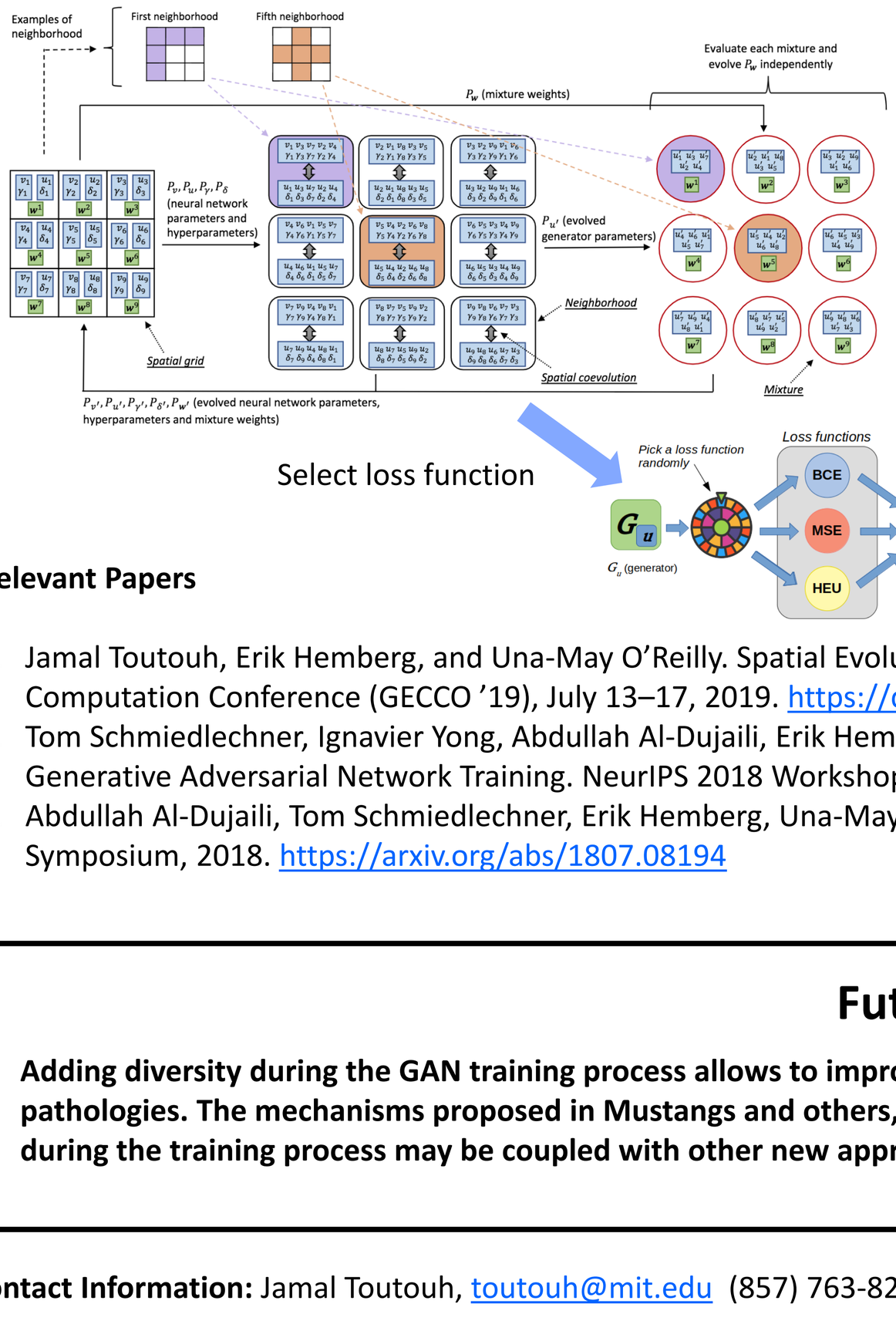
- Simultaneous gradient updates in GAN training lead to **unstable dynamics**
- Similar degenerate behaviors have been studied by the coevolutionary computing for minimax optimization
  - **Mode Collapse** **Focusing**
  - **Discriminator Collapse** **Relativism**
  - **Vanishing Gradients** **Loss of Gradients**

- Supplementing coevolutionary GAN training with diversity in the loss function (mutation) space to address unstable dynamics.

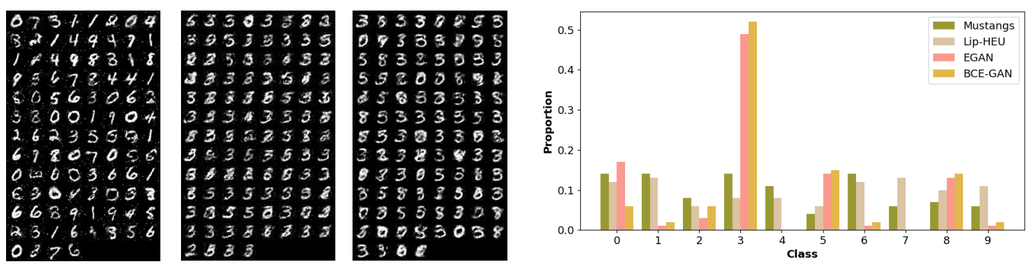
Mustangs: Coevolutionary Diversity Training

Mustangs is a distributed, coevolutionary framework to simultaneously train multiple GANs with gradient-based optimizers

For each iteration, each network **randomly picks a loss function** to optimize its weights according to different objectives



Results



Mustangs BCE-GAN EGAN Diversity of the generated data

Figure: MNIST results

Mustangs Lipizzaner (Lip-BCE) FID Score

Figure: CelebA results

Open source implementation:

- https://github.com/mustang-gan/

Relevant Papers

1. Jamal Toutouh, Erik Hemberg, and Una-May O'Reilly. Spatial Evolutionary Generative Adversarial Networks. In Genetic and Evolutionary Computation Conference (GECCO '19), July 13–17, 2019. https://doi.org/10.1145/3321707.3321860
2. Tom Schmiedlechner, Ignavier Yong, Abdullah Al-Dujaili, Erik Hemberg, Una-May O'Reilly. Lipizzaner: A System That Scales Robust Generative Adversarial Network Training. NeurIPS 2018 Workshop on System for ML, 2018. https://arxiv.org/abs/1811.12843
3. Abdullah Al-Dujaili, Tom Schmiedlechner, Erik Hemberg, Una-May O'Reilly. Towards distributed coevolutionary GANs. AAAI 2018 Fall Symposium, 2018. https://arxiv.org/abs/1807.08194

Future vision

Adding diversity during the GAN training process allows to improve the robustness, and therefore, to overcome often observed pathologies. The mechanisms proposed in Mustangs and others, such as diversity in terms of training data, to foster diversity during the training process may be coupled with other new approaches to train GANs with the aim of improving the results.

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