Analyzing the Components of Distributed Coevolutionary GAN Training

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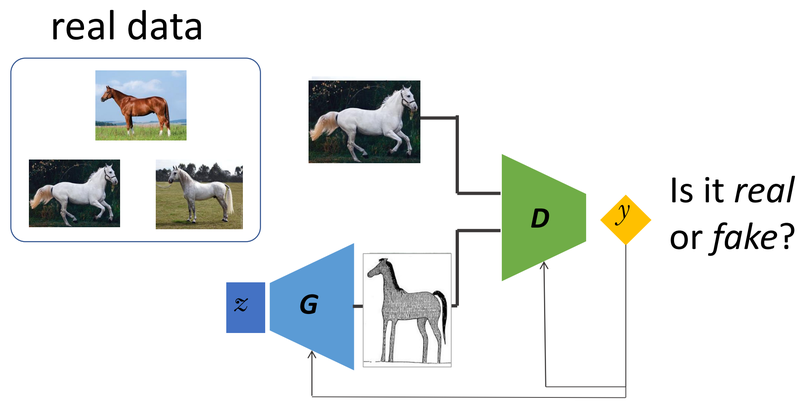
Motivation

Generative Adversarial Networks (GANs) construct a generative model by training two neural networks, a generator G and a discriminator D, using adversarial learning



Lipizzaner Distributed Coevolutionary GAN training shows:

- Fast and improved convergence due to gradient-based steps
- Robustness and resilience due to coevolution
- Diverse solutions due to mixture evolution
- Scalability due to spatial distribution topology

Main research question: *What is the effect of the main components of this type of training?*

Distributed Coevolutionary GAN Training Ablations

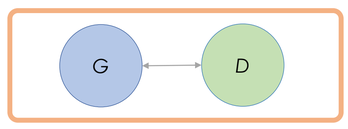
Lipizzaner

- creates **sub-populations** from neighborhoods
- **exchanges information** (updated networks) among the sub-populations after each training epoch
- applies **selection/replacement** of the center (*best*) network of the population

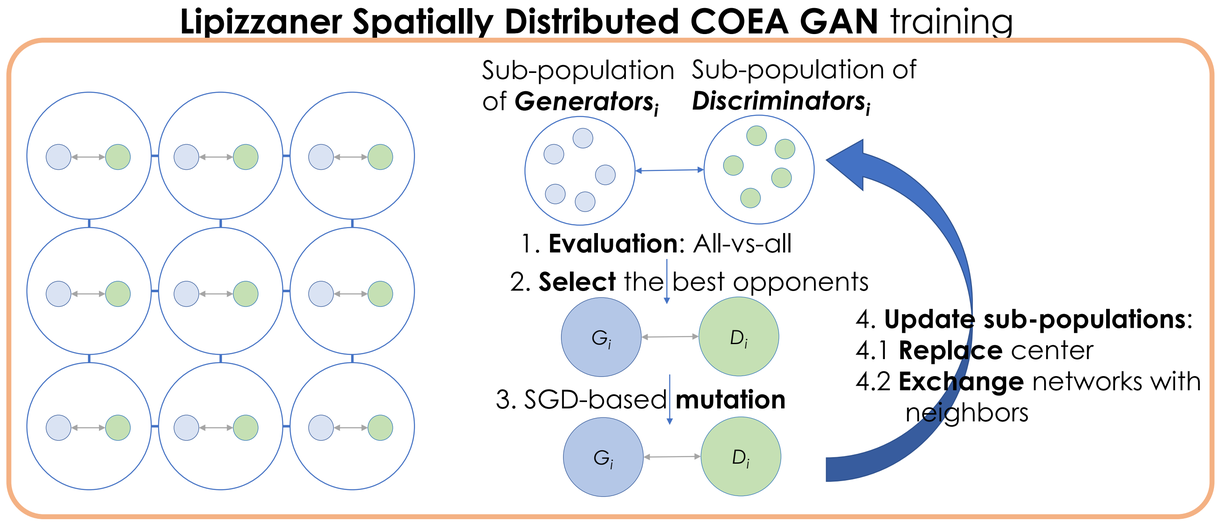
Three ablations: Spatial GAN (**SPaGAN**), Isolated CoEA GAN (**IsoCoGAN**), and Parallel GAN (**PaGAN**)

Feature	SPaGAN	IsoCoGAN	PaGAN
Use of sub-populations	Yes	Yes	No
Communication between sub-populations	Yes	No	No
Application of selection/replacement	No	Yes	No

Single-GAN training



Lipizzaner Spatially Distributed COEA GAN training

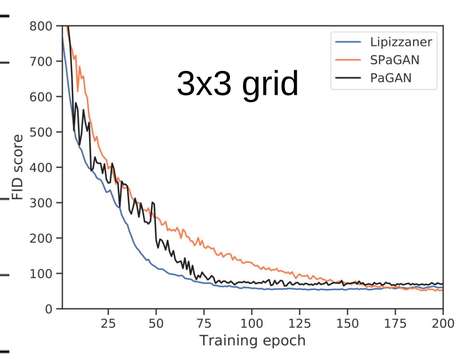


Experimental Analysis

Generator Quality (FID)

Lower is better

Grid	Method	Mean±Std
3×3	Lipizzaner	**40.93±8.51**
	SPaGAN	43.59±5.53
	IsoCoGAN	881.79±52.67
	PaGAN	51.15±14.06
4×4	Lipizzaner	**32.84±6.93**
	SPaGAN	37.97±8.89
5×5	Lipizzaner	**28.74±4.91**
	SPaGAN	39.11±4.00



Output Diversity (TVD)

Lower is better

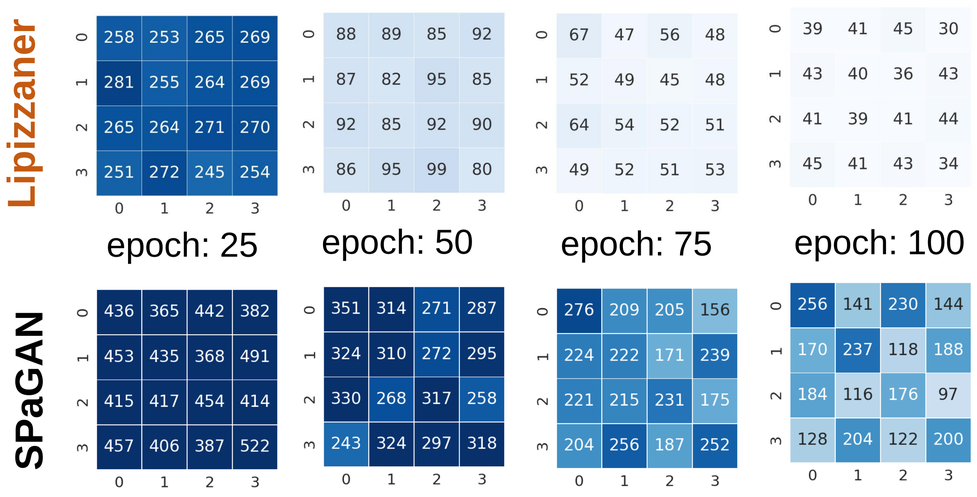
Grid	Method	Mean±Std
3×3	Lipizzaner	0.12±0.03
	SPaGAN	**0.12±0.02**
	IsoCoGAN	0.83±0.08
	PaGAN	0.14±0.02
4×4	Lipizzaner	**0.11±0.02**
	SPaGAN	0.12±0.02
5×5	Lipizzaner	**0.10±0.02**
	SPaGAN	0.11±0.02

Execution time (mins)

Lower is better

Grid	Method	Mean±Std
3×3	Lipizzaner	87.89±1.15
	SPaGAN	87.20±0.31
	IsoCoGAN	81.88±4.55
	PaGAN	**38.07±2.73**
4×4	Lipizzaner	91.30±0.94
	SPaGAN	**90.72±0.58**
5×5	Lipizzaner	105.64±3.25
	SPaGAN	**101.88±1.64**

4x4 Lipizzaner and SPaGAN Generators Evolution



Conclusions

- The combination of selection pressure, that promotes convergence, and communication with the overlapped neighborhoods applied by **Lipizzaner** is the best choice.
- **SPaGAN** emphasizes the value of exchanging the best individuals
- **IsoCoGAN** shows that training GANs with a COEA flavor does not ensure convergence