Twin Auxiliary Classifiers GAN

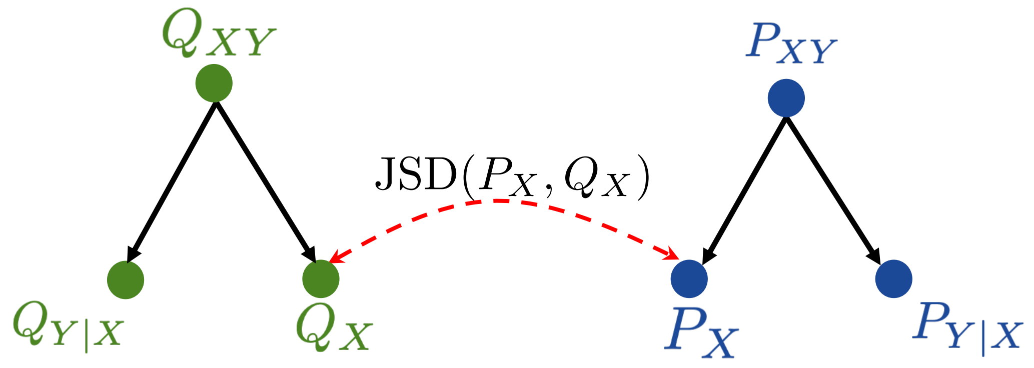
NeurIPs 2019

AC-GAN: Density Matching Point of View

$$\min_{G,C} \max_{D} \ \mathcal{L}_{GAN}(G, D)$$

$$- \mathop{\mathbb{E}}_{(X,Y)\sim P_{XY}} [\log C(X, Y)]$$

$$- \mathop{\mathbb{E}}_{Z\sim P_Z, Y\sim P_Y} [\log(C(G(Z, Y), Y))]$$



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$$\overbrace{-\mathop{\mathbb{E}}_{(X,Y)\sim P_{XY}}[\log C(X,Y)]\ \boxed{-H_P(Y|X)}}$$

This is a constant
(It doesn't matter!)

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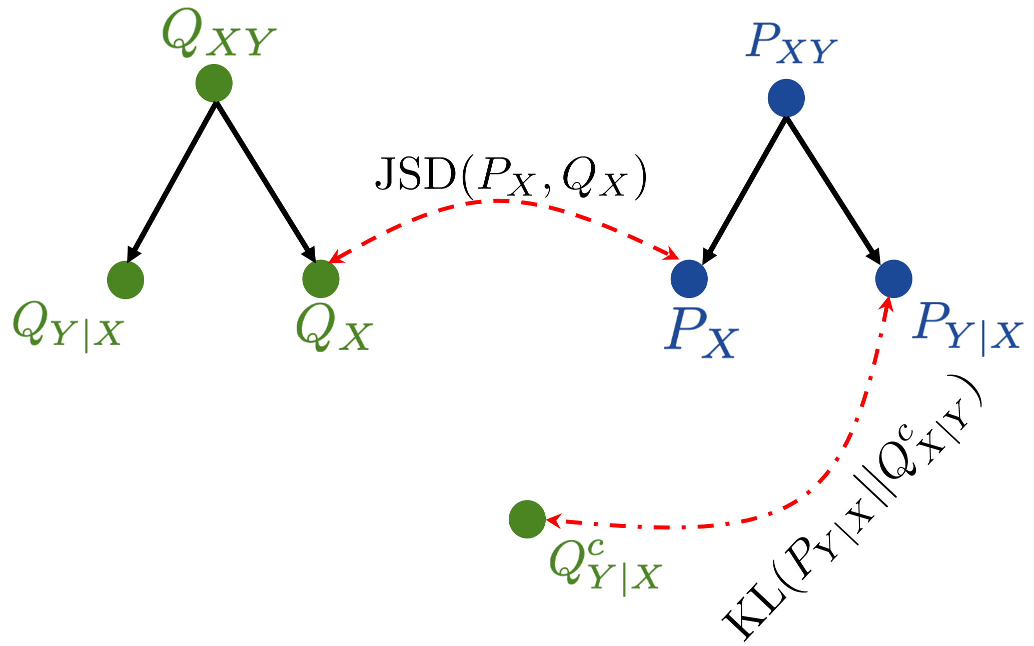

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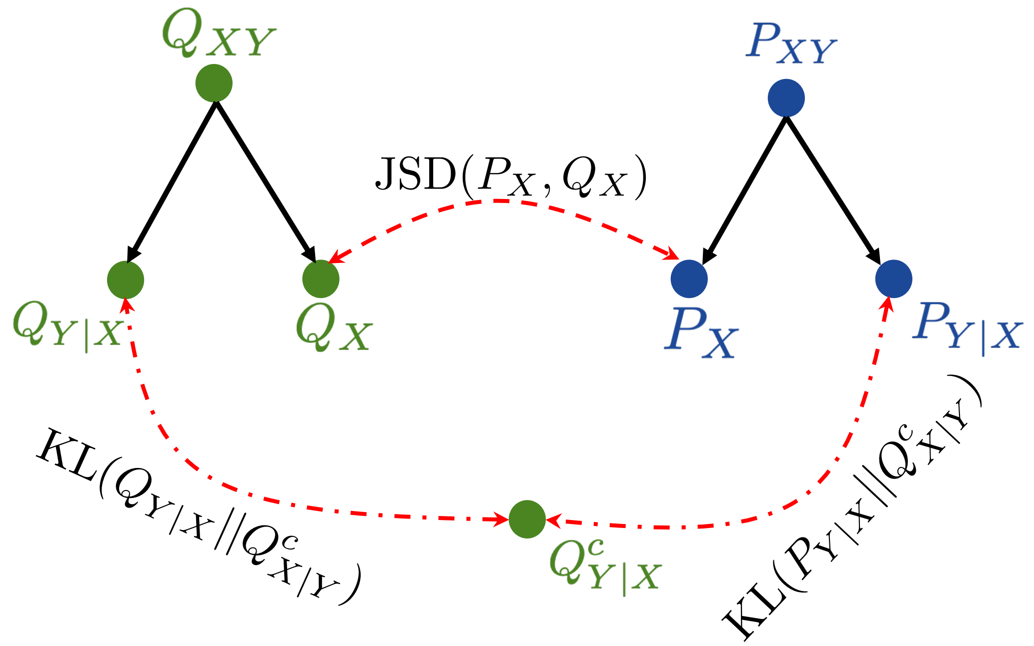
This is **NOT** a constant b/c of G



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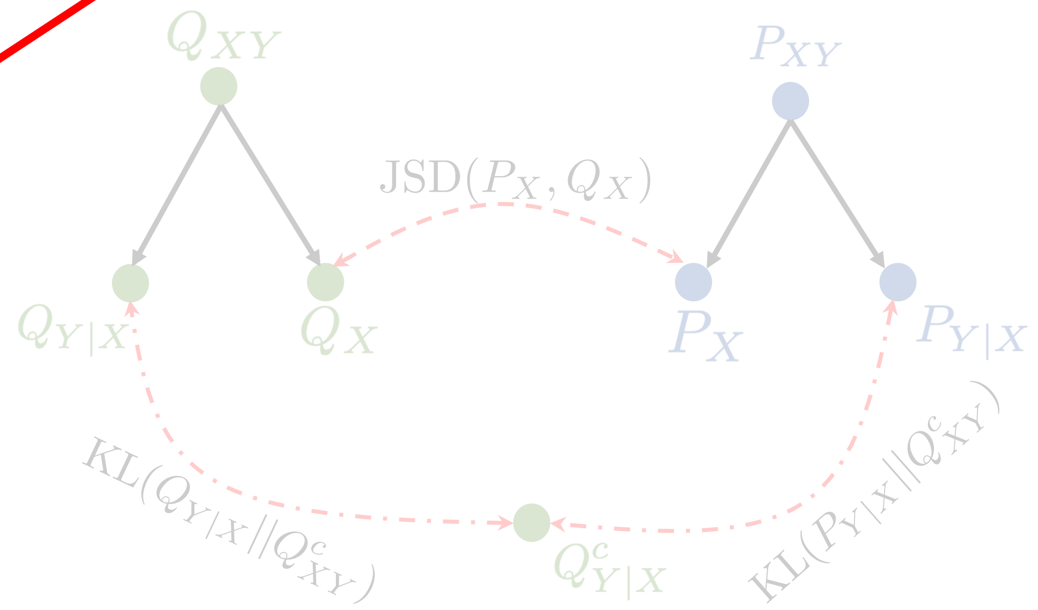
(Missing term!)

Missing term in AC-GAN
Very difficult to estimate directly!



Conversion to a Min-Max Game

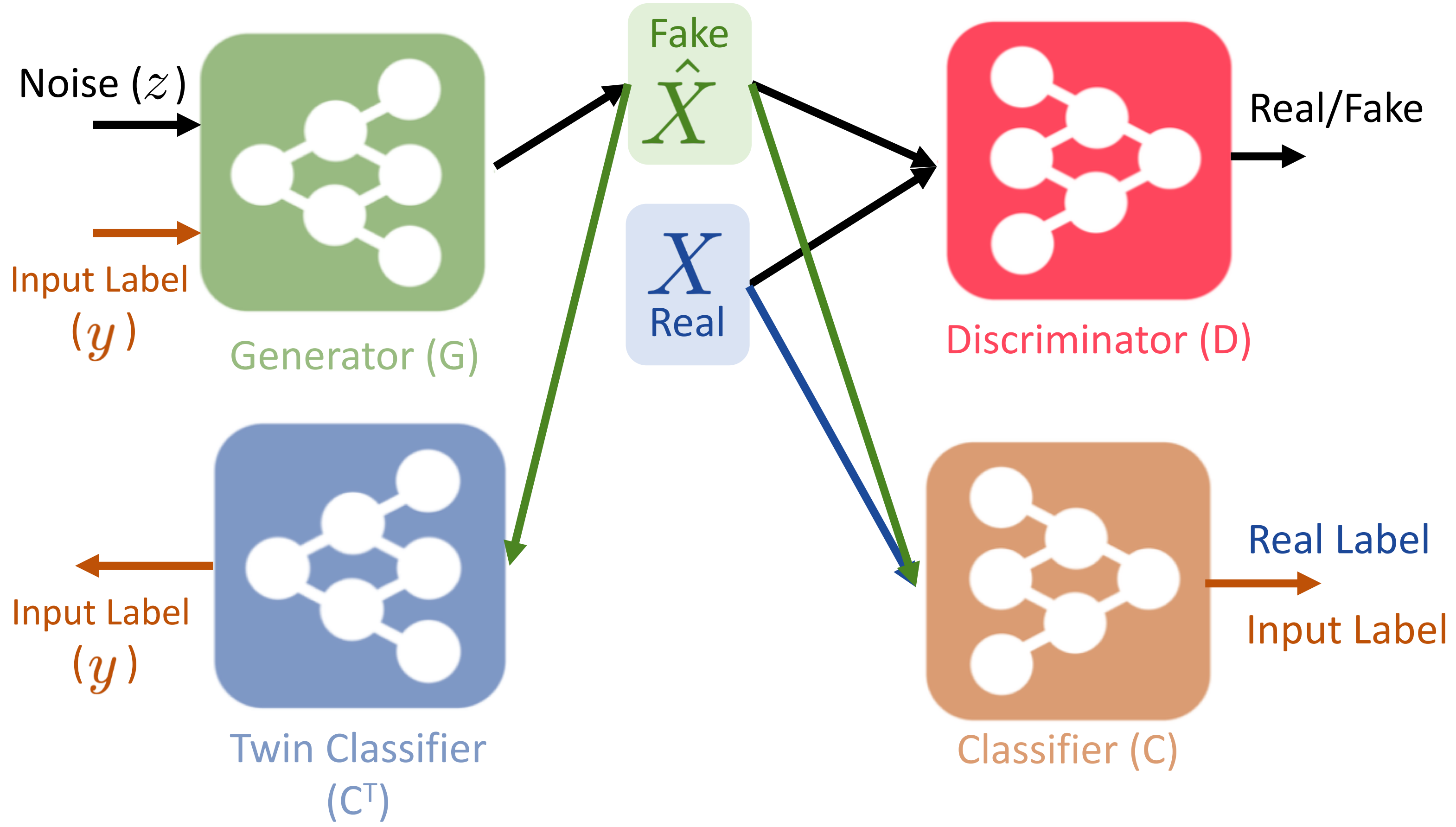
Proposition:

- If $p(Y)$ is a uniform distribution, the following are equivalent:
  - Maximizing $H_Q(Y|X)$
  - Minimizing $I_Q(X,Y)$
  - Minimizing $JSD(Q_{X|Y=1}, Q_{X|Y=2}, \cdots, Q_{X|Y=K})$

A Min-Max game can be introduced!

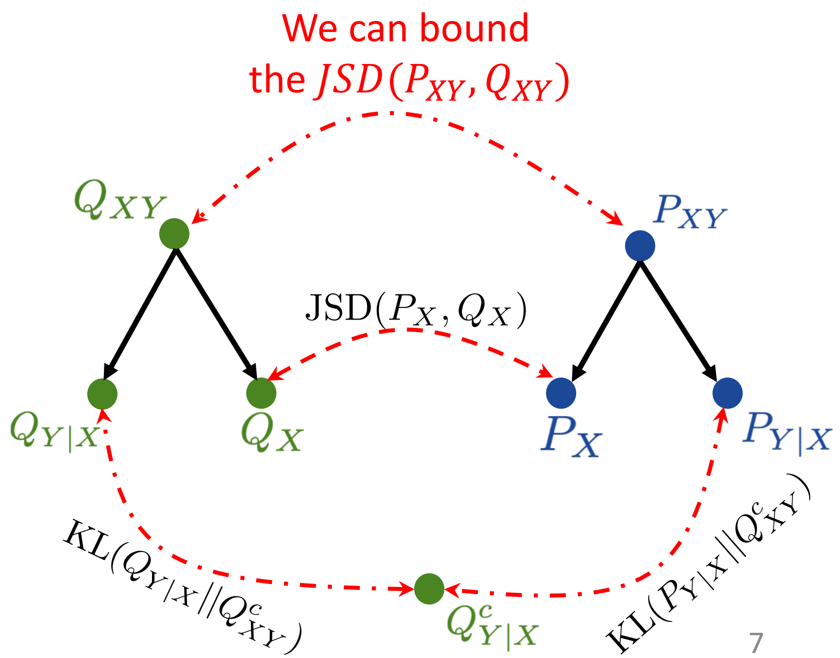
M. Gong, Y. Xu, C. Li, K. Zhang, K. Batmanghelich, "Twin Auxiliary Classifiers GAN," *to be appear NeurIPS*, 2019

Twin Auxiliary Players



- The twin player (C^T) only works on "Fake" samples.
- The Generator (G) tries to makes fake samples indistinguishable for C^T.
- Minimax is achieved at:

$$JSD\left(Q_{X|Y=1}, Q_{X|Y=2}, \cdots, Q_{X|Y=K}\right) = 0$$



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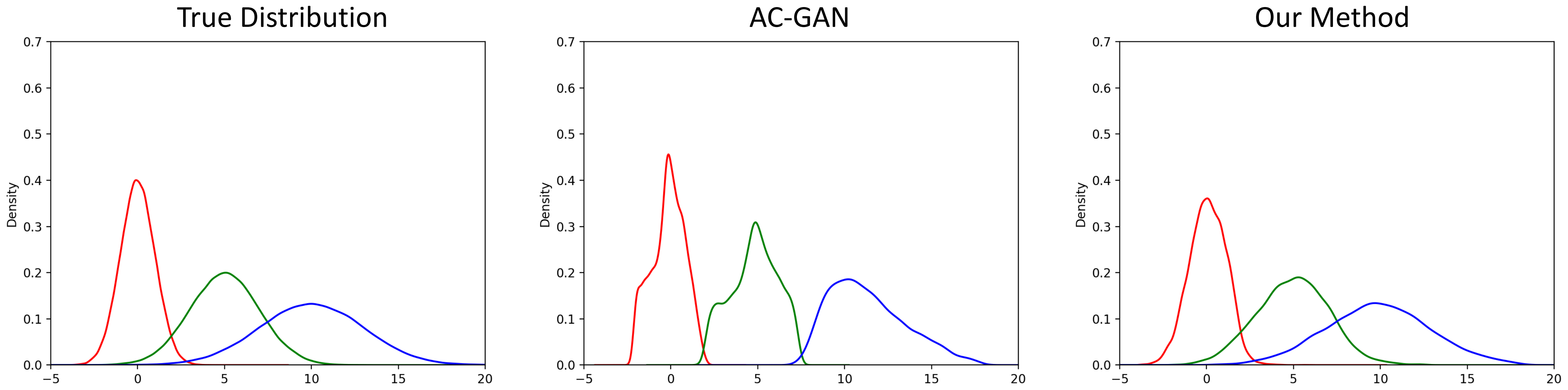
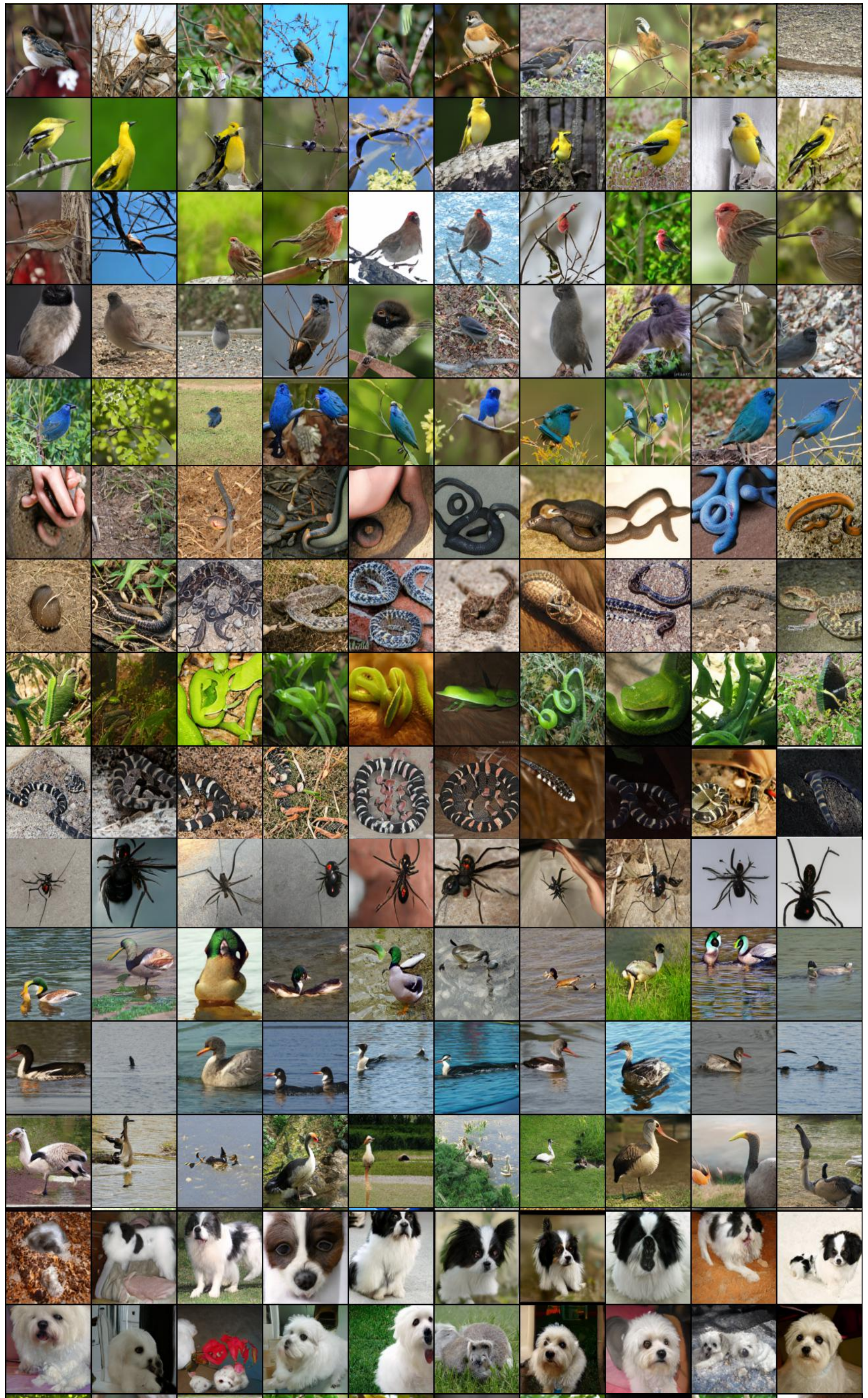
Outlines

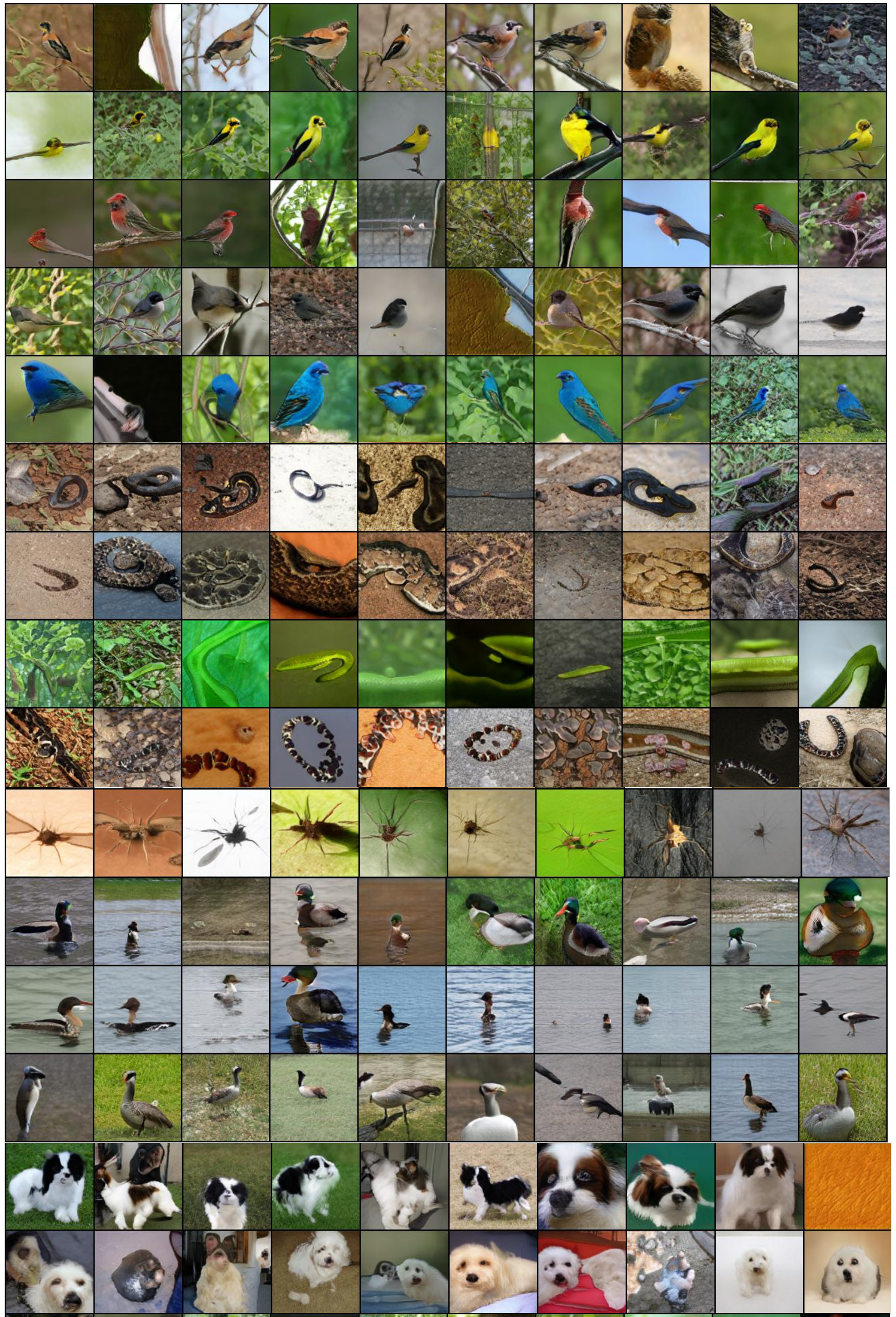
- Review of GANs and conditional-GANs
- Issues with ACGAN
- Twin Auxiliary Classifiers GANs
- Results
- Applications (time permits)

Going Back to the 1D Case



TAC-GAN (Ours)





Projection cGAN

TAC-GAN (Ours)

Projection cGAN

Quantitative Comparison

Methods	AC-GAN ($\lambda_c = 1$)			TAC-GAN (Ours) ($\lambda_c = 1$)			Projection cGAN		
Metrics	IS ↑	FID ↓	LPIPS ↑	IS ↑	FID ↓	LPIPS ↑	IS ↑	FID ↓	LPIPS ↑
CIFAR100	5.37 ± 0.064	82.45	0.003	9.34 ± 0.077	**7.22**	0.165	**9.56 ± 0.133**	8.92	**0.169**
ImageNet1000	7.26 ± 0.113	184.41	0.058	28.86 ± 0.298	23.75	**0.634**	**38.05 ± 0.790**	**22.77**	0.616
VGGFace200	27.81 ± 0.29	95.70	0.023	**48.94 ± 0.63**	**29.12**	0.260	32.50 ± 0.44	66.23	**0.270**
VGGFace500	25.96 ± 0.32	31.90	0.031	**77.76 ± 1.61**	**12.42**	**0.269**	35.96 ± 0.62	43.10	0.130
VGGFace1000				**108.89 ± 2.63**	**13.60**		71.15 ± 0.93	24.07	
VGGFace2000				**109.04 ± 2.44**	**13.79**		79.51 ± 1.03	22.42	

Richard Zhang, Phillip Isola, Alexei A Efros, Eli Shechtman, and Oliver Wang. The Unreasonable Effectiveness of Deep Features as a Perceptual Metric. In *CVPR*, 2018.

Acknowledgements

R01: An Integrative Radiogenomic Approach to Design Genetically- Informed Image Biomarker for Characterizing COPD.

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Tripods+X: Learning with Expert-In-The- Loop for Multimodal Weakly Labeled Data and an Application to Massive Scale Medical Imaging.

Research Sponsored: Developing Statistical Method to Jointly Model Genotype and High Dimensional Phenotype .