Variational Auto-encoders...?
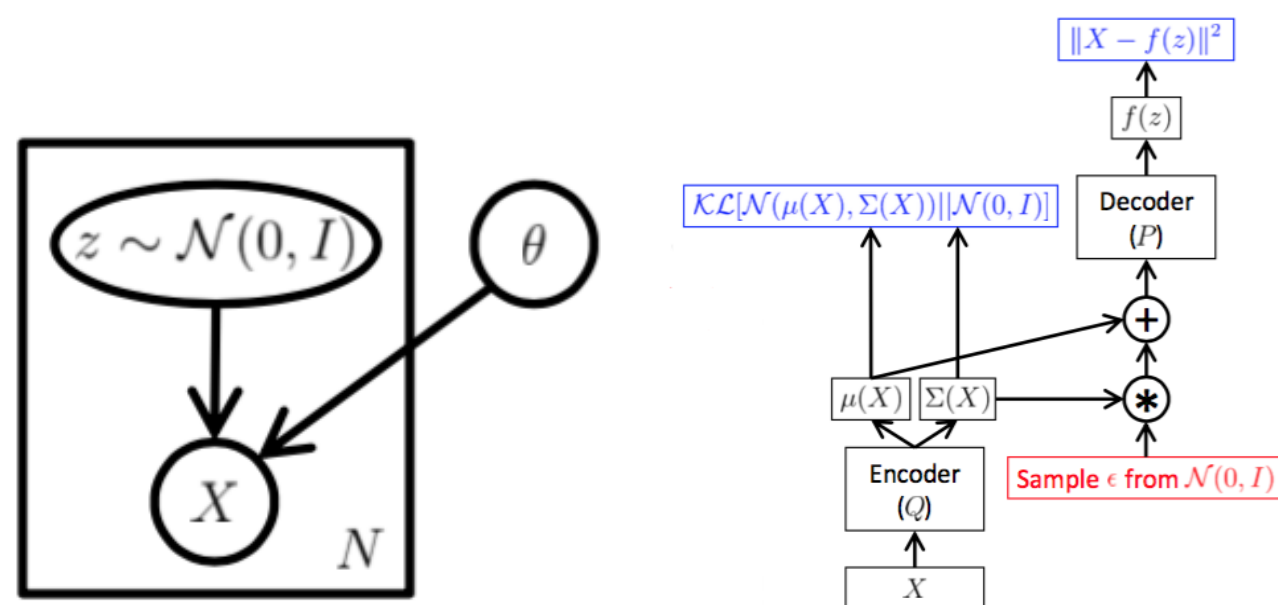
Jianbo Chen, Billy Fang, Cheng Ju   *Departments of Statistics and Biostatistics, UC Berkeley*   CS 294-129, Fall 2016
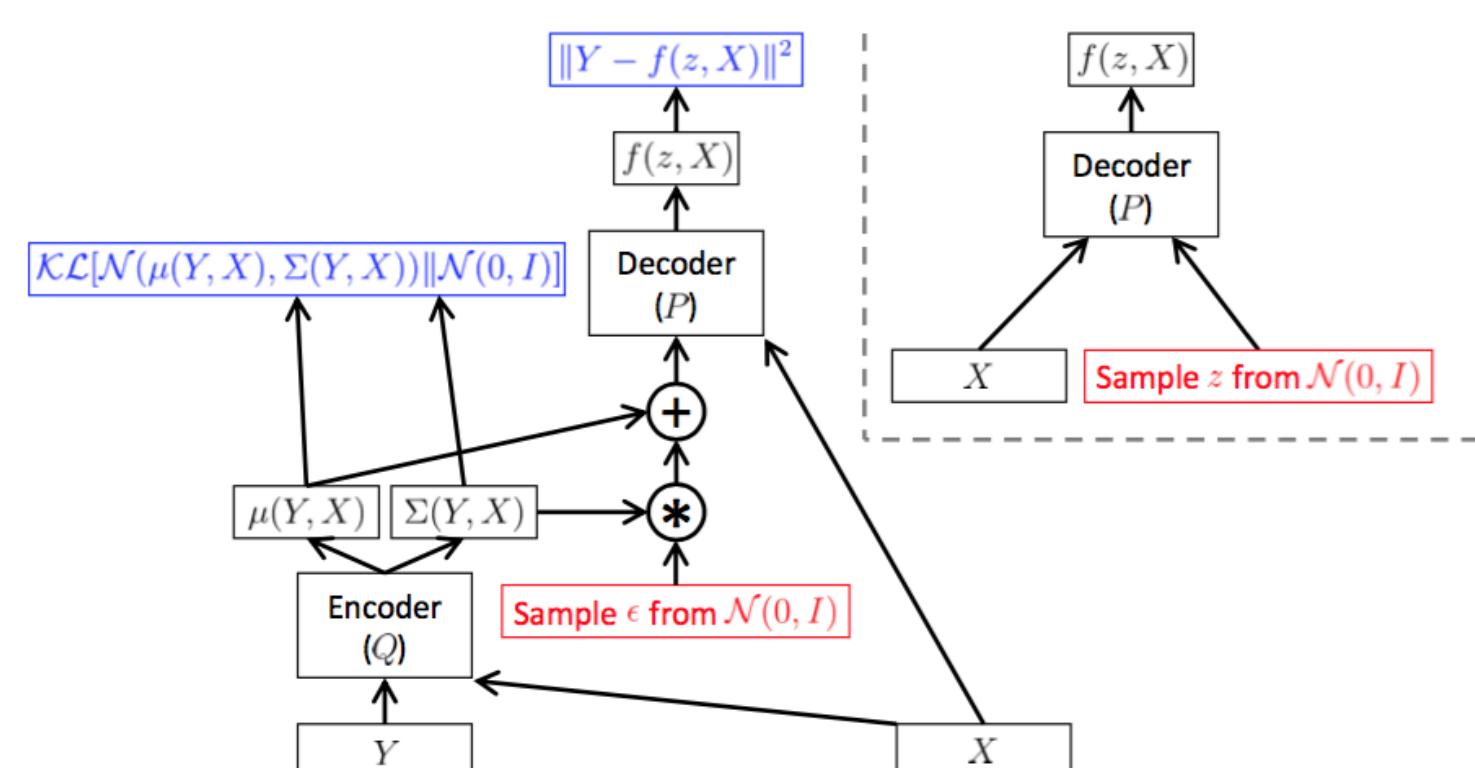
Background

- Variational auto-encoders are useful for generating new examples from observed data
- Learns latent encoding of data
- Can be used for semi-supervised learning

VAE

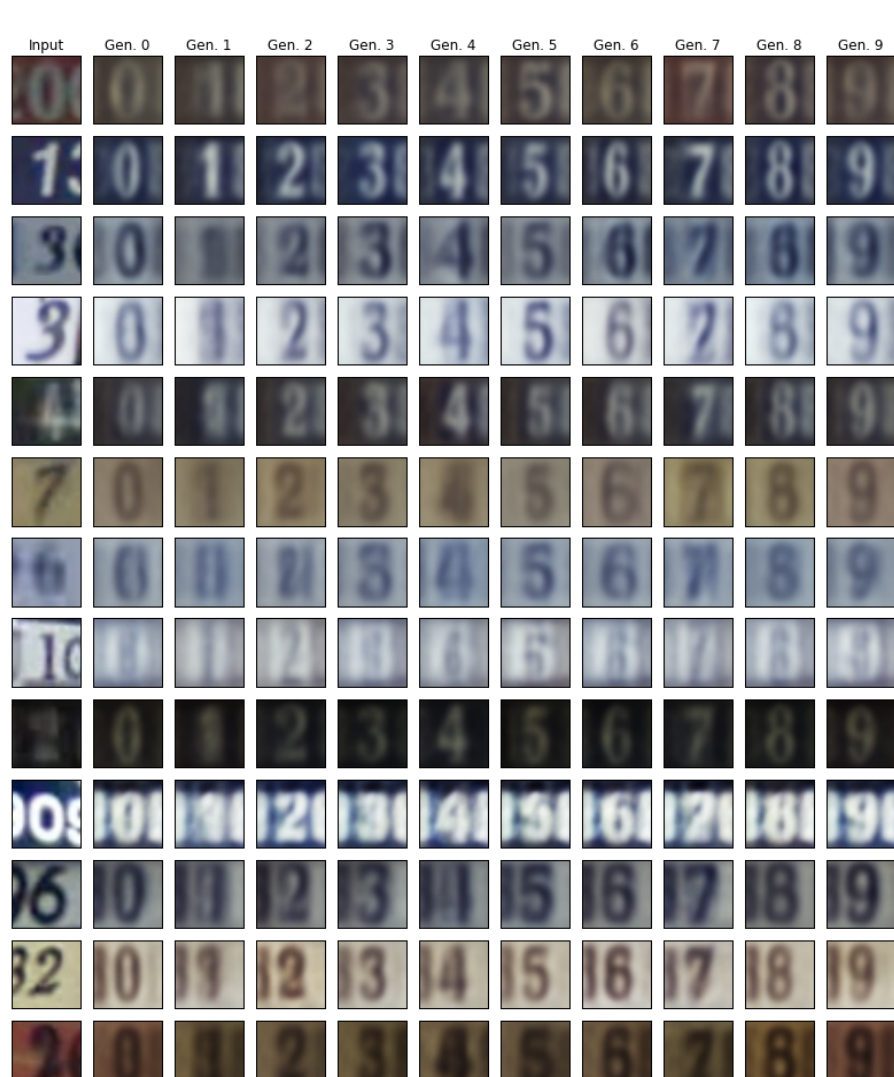$$\log p(x) \geq \mathbb{E}_{z \sim Q(\cdot|x)}[\log p(x \mid z)] - \mathrm{KL}(Q(z \mid x)\|p(z)).$$

CVAE

$$\log p(x \mid y) \geq \mathbb{E}_{z \sim Q(\cdot|y,x)}[\log p(x \mid y, z)] - \mathrm{KL}(Q(z \mid x, y)\|p(z \mid y)).$$

CVAE for completion

CVAE for style transfer

Semi-supervised learning

- Handle datasets with missing labels
- Models label distribution
- Labeled and unlabeled examples enter loss differently

$$\log p(x,y) \geq \mathbb{E}_{z \sim Q(z|x,y)}[\log p(x \mid y, z) + \log p(y)]$$
$$- \mathrm{KL}(Q(z \mid x, y)\|p(z)) =: -\mathcal{L}(x,y)$$
$$\log p(x) \geq \sum_y q(y \mid x)(-\mathcal{L}(x,y)) + H(q(y \mid x))$$
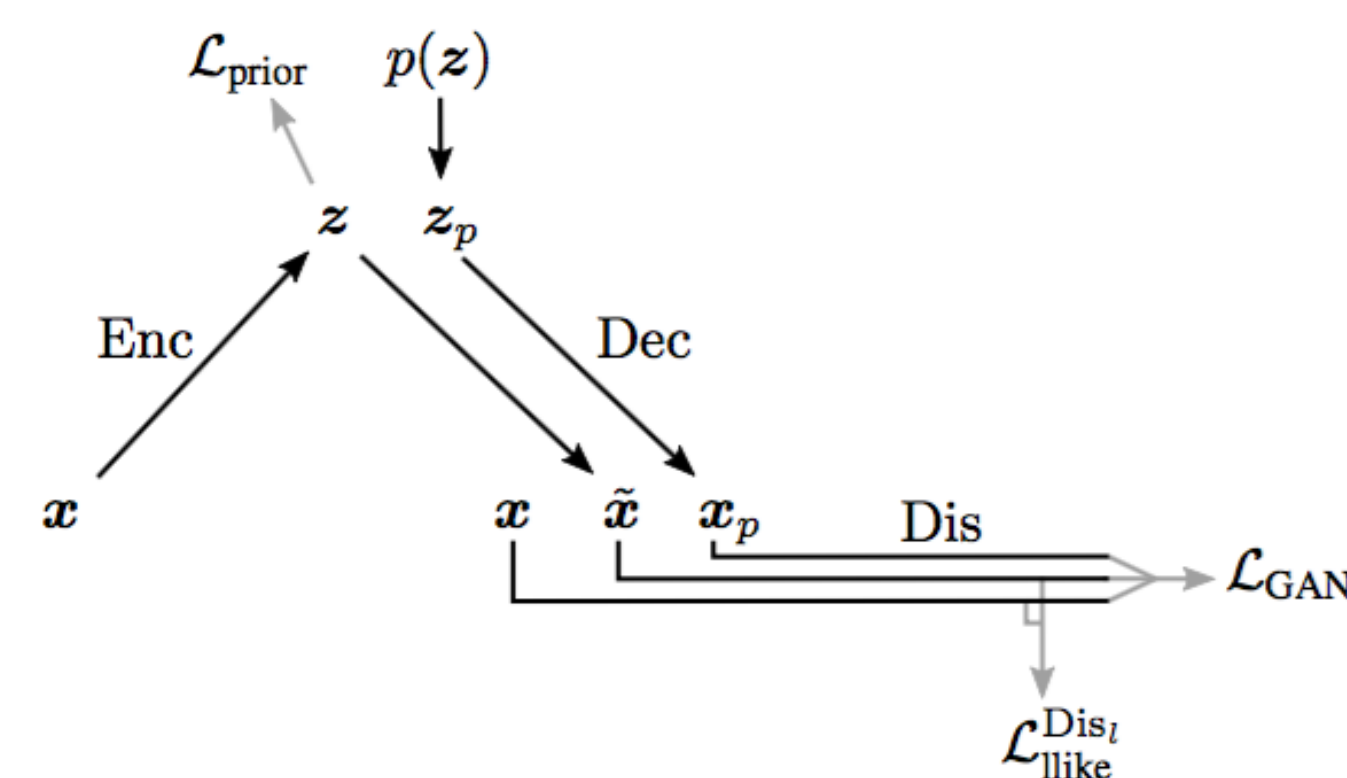
Validation/test error on MNIST

	1000 labeled	600 labeled
Fully connected	4.7%/ 5.1%	11.5%/12.0%
Convolutional	4.2%/4.8%	6.0%/6.2%
Kingma et al. [3]	2.4%	2.6%

Adding GANs

- VAE output is often blurry
- Add discriminator to encourage sharpness
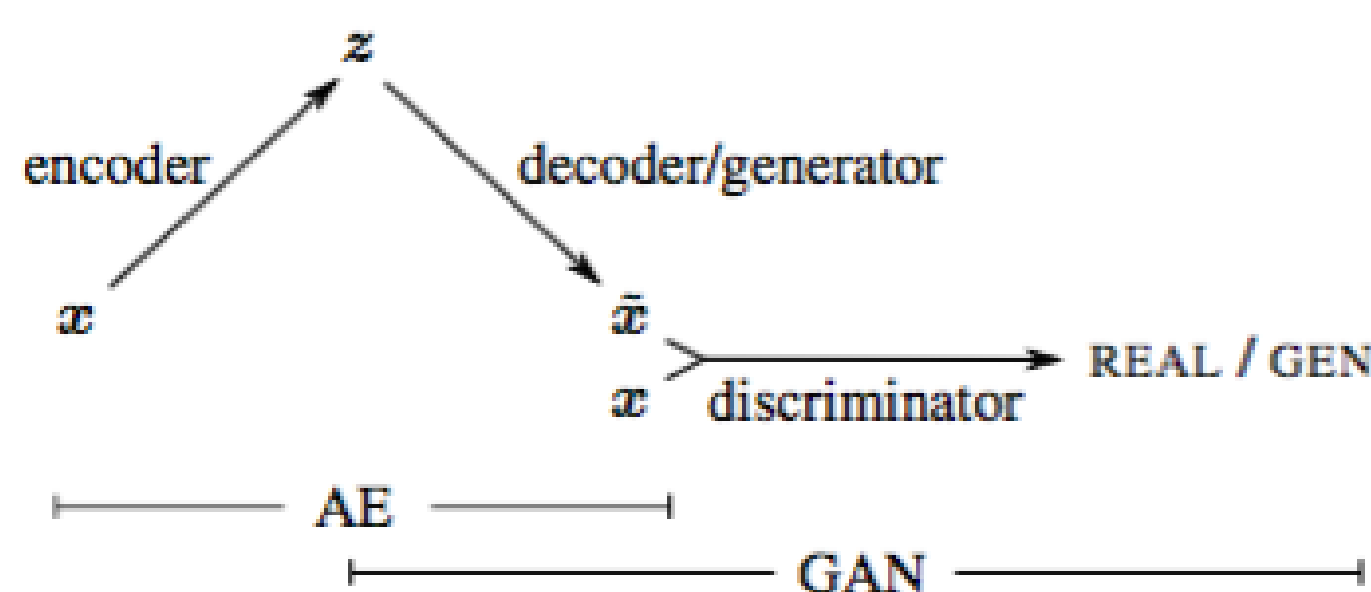
Replace decoder loss with comparison of discriminator layers

CVAEGAN

CVAEGAN results here

Deep feature loss

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Future Directions

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References

[1] Carl Doersch. Tutorial on variational autoencoders. *arXiv preprint arXiv:1606.05908*, 2016.

[2] Xianxu Hou, Linlin Shen, Ke Sun, and Guoping Qiu. Deep feature consistent variational autoencoder. *arXiv preprint arXiv:1610.00291*, 2016.

[3] Diederik P Kingma, Shakir Mohamed, Danilo Jimenez Rezende, and Max Welling. Semi-supervised learning with deep generative models. In *Advances in Neural Information Processing Systems*, pages 3581–3589, 2014.

[4] Diederik P Kingma and Max Welling. Auto-encoding variational bayes. *arXiv preprint arXiv:1312.6114*, 2013.

[5] Anders Boesen Lindbo Larsen, Søren Kaae Sønderby, and Ole Winther. Autoencoding beyond pixels using a learned similarity metric. *arXiv preprint arXiv:1512.09300*, 2015.