

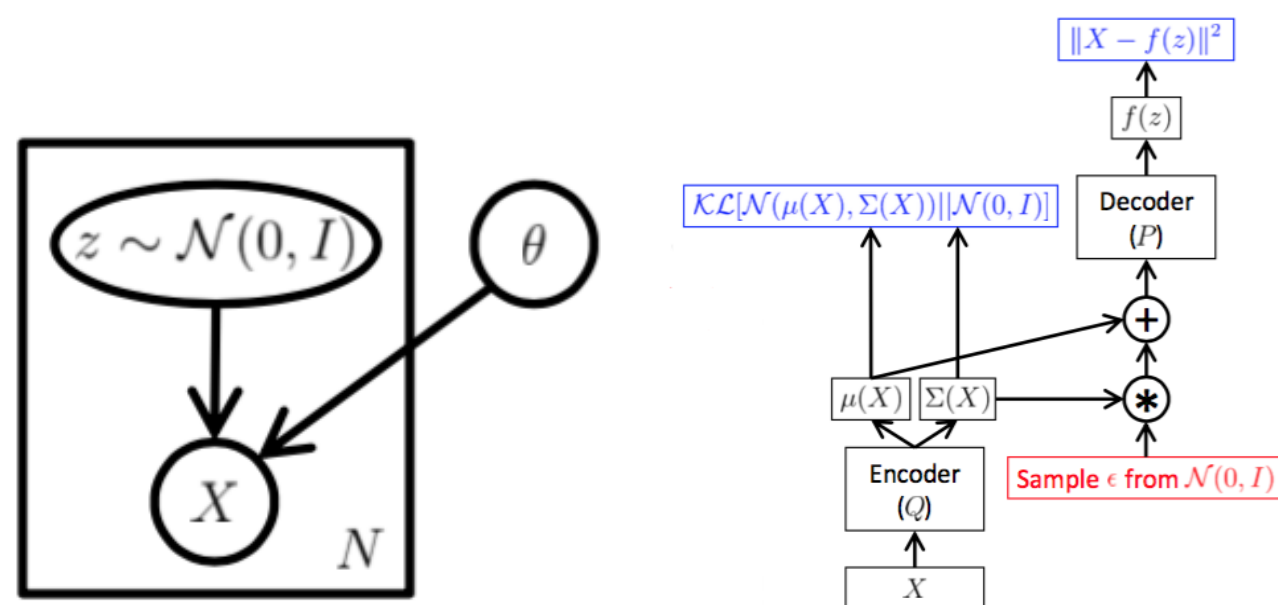
VARIATIONAL AUTO-ENCODERS...?

JIANBO CHEN, BILLY FANG, CHENG JU *Departments of Statistics and Biostatistics, UC Berkeley* CS 294-129, FALL 2016

BACKGROUND

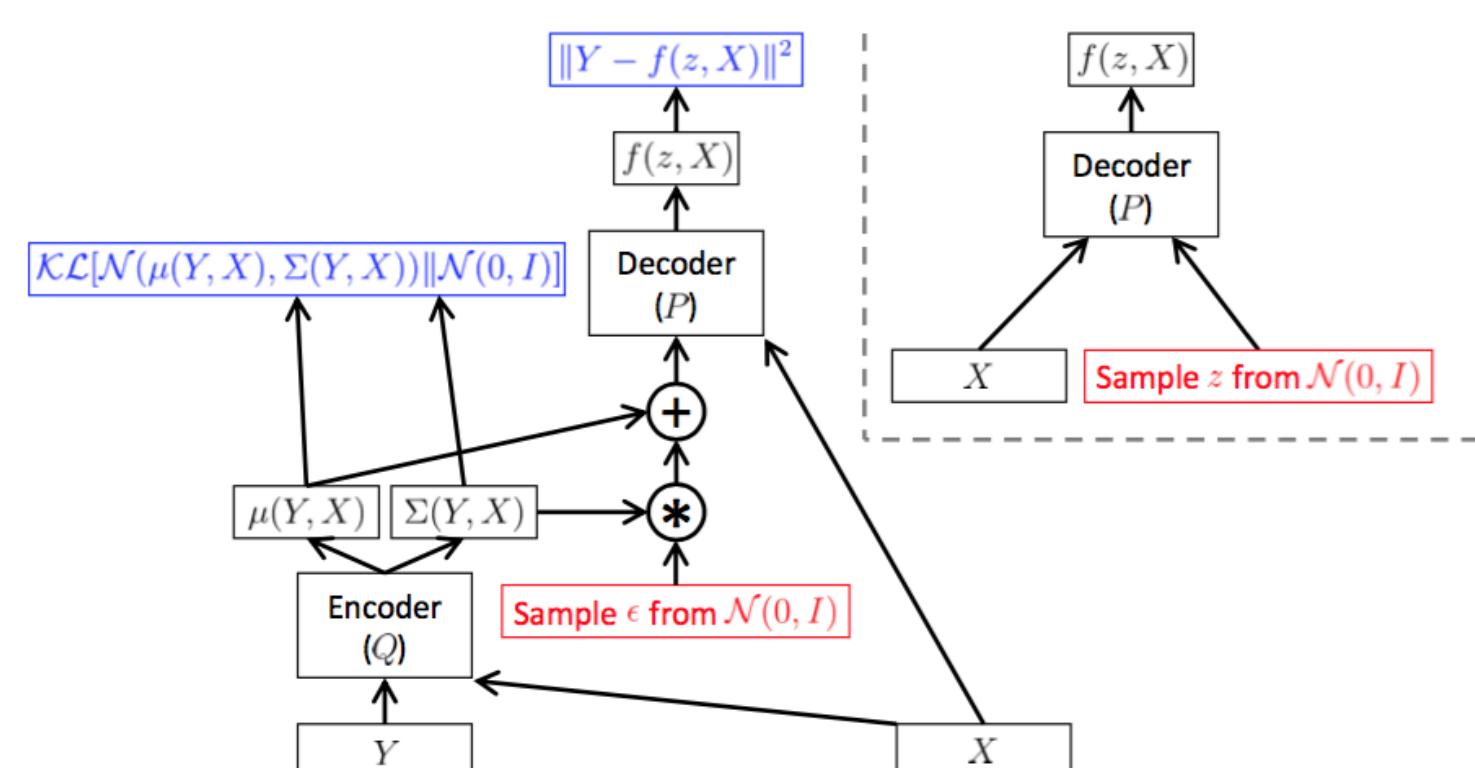
- Variational auto-encoders are useful for generating new examples from observed data
- Learns latent encoding of data
- Can be used for semi-supervised learning

VAE



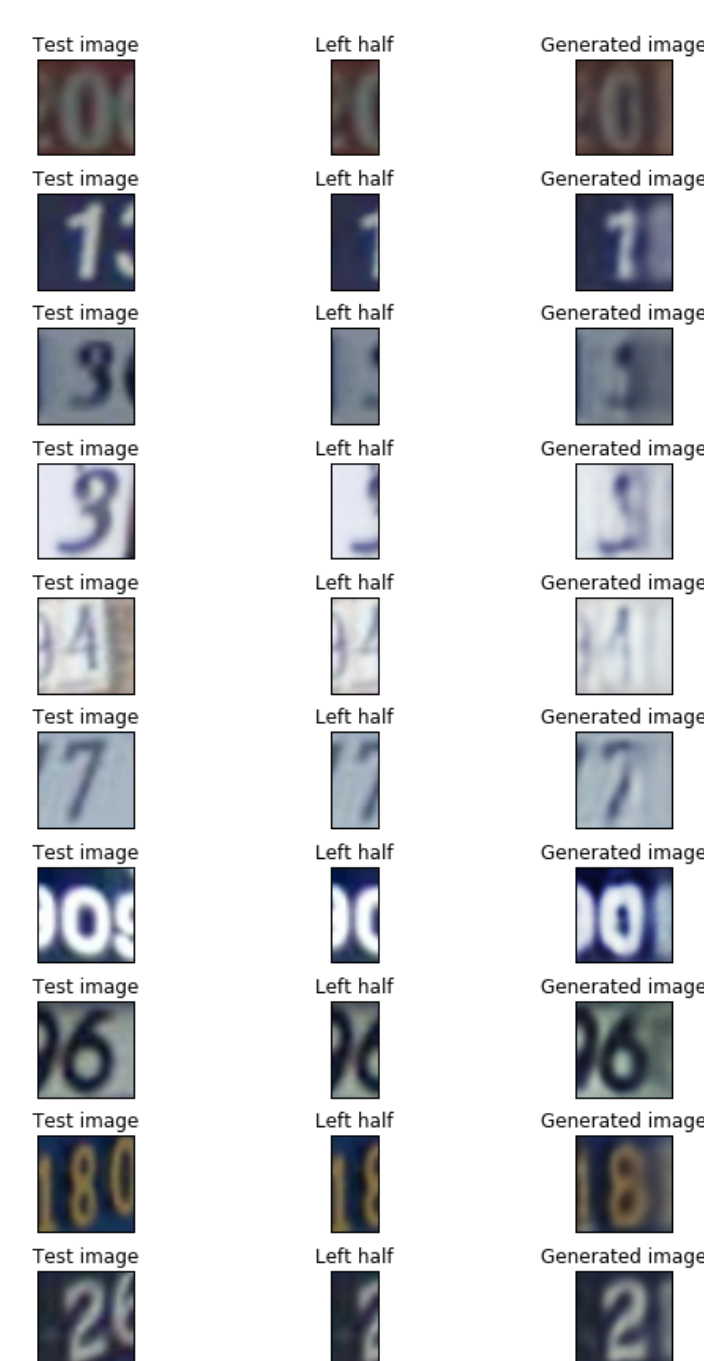
$$\log p(x) \geq \mathbb{E}_{z \sim Q(\cdot|x)} [\log p(x|z)] - \text{KL}(Q(z|x)||p(z)).$$

CVAE

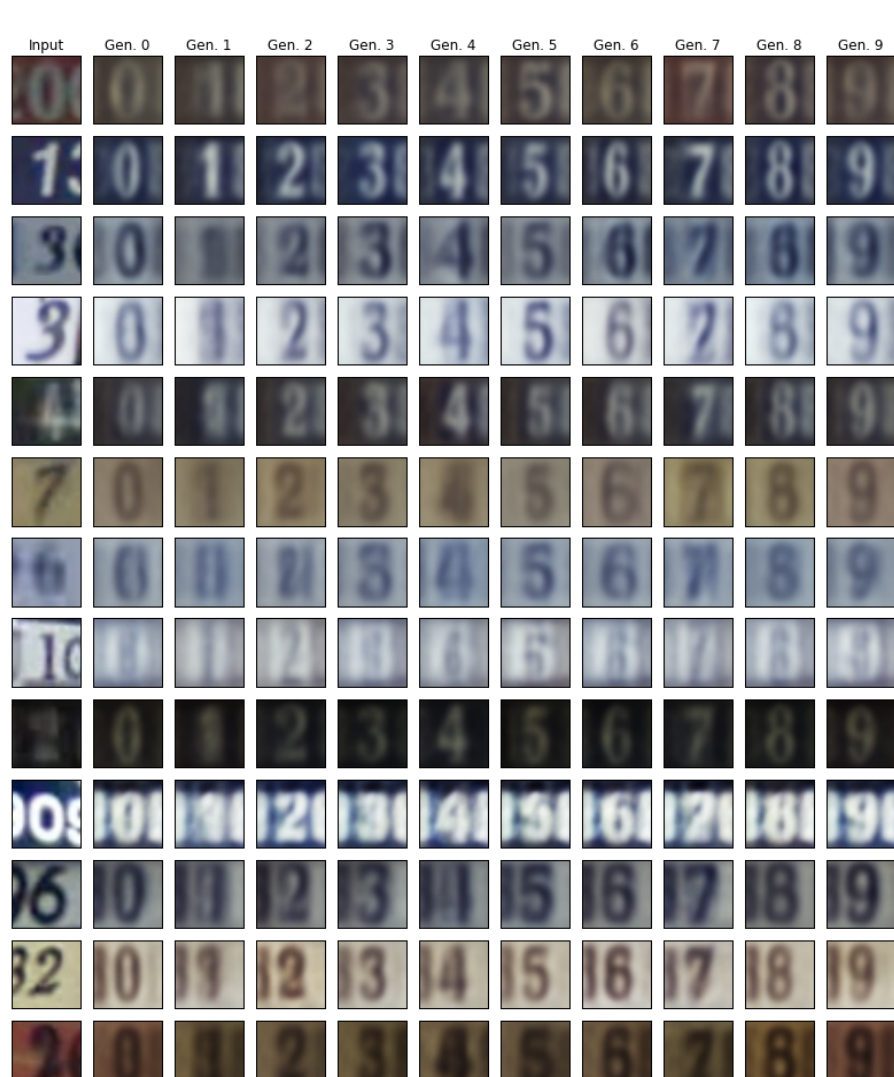


$$\log p(x|y) \geq \mathbb{E}_{z \sim Q(\cdot|y,x)} [\log p(x|y,z)] - \text{KL}(Q(z|x,y)||p(z|y)).$$

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

$$\log p(x, y) \geq \mathbb{E}_{z \sim Q(z|x,y)} [\log p(x|y,z) + \log p(y)] - \text{KL}(Q(z|x,y)||p(z)) =: -\mathcal{L}(x, y)$$

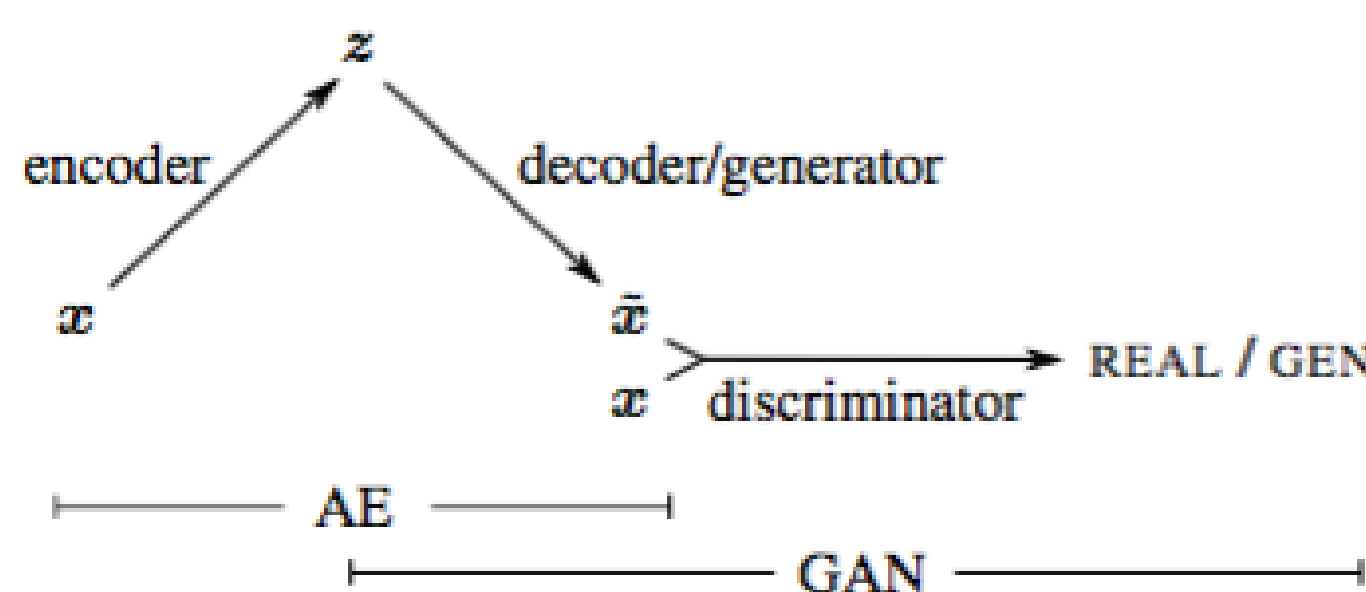
$$\log p(x) \geq \sum_y q(y|x) (-\mathcal{L}(x, y)) + H(q(y|x))$$

Validation/test error on MNIST

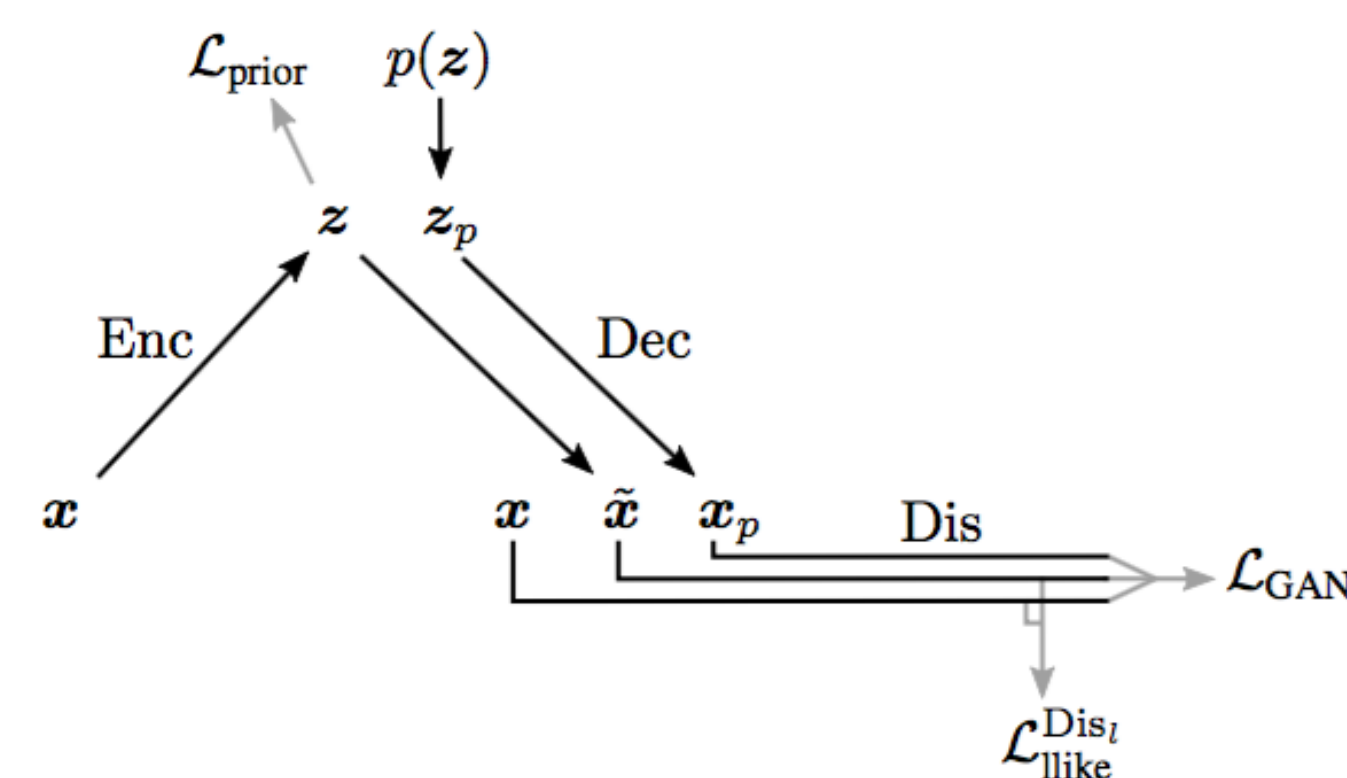
	1000 labeled	600 labeled
Fully connected	4.7% / 5.1%	11.5% / 12.0%
Convolutional	4.2% / 4.8%	7.0% / 7.2%
Kingma et al. [3]	2.4%	2.6%

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.