A TWO-STEP DISENTANGLEMENT METHOD

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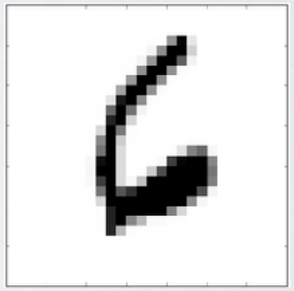
DISENTANGLED REPRESENTATION

- A disentangled representation can be defined as one where single **latent units** are sensitive to changes in single generative factors, while being relatively invariant to changes in other factors

z1
z2
z3
z4
z5
z6

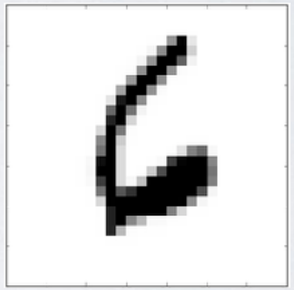


Source: Bengio, Yoshua, Aaron Courville, and Pascal Vincent. "Representation learning: A review and new perspectives." *IEEE transactions on pattern analysis and machine intelligence* 35.8 (2013): 1798-1828.

RELATED WORKS

- Beta-VAE
  - Encourages the latent representation to be factorised by adding beta to VAE objective

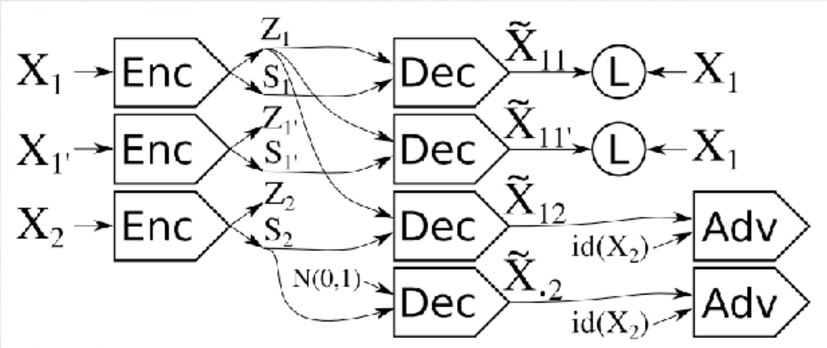
Independent	
Number	z1
x location	z2
y location	z3
Rotation	z4
Thickness	z5
Tilted	z6



Source: Higgins, Irina, et al. "beta-vae: Learning basic visual concepts with a constrained variational framework." (2016).

RELATED WORKS

- Disentangling factors of variation in deep representations using adversarial training
  - Divide information into content codes (Label), style codes (Else)

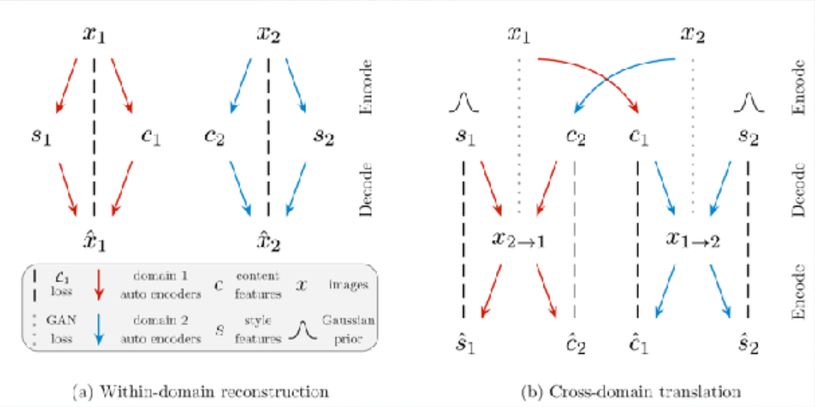


Number	z1
Number	z2
Style	z3
Style	z4
Style	z5
Style	z6

Source: Mathieu, Michael F., et al. "Disentangling factors of variation in deep representation using adversarial training." *Advances in Neural Information Processing Systems*. 2016.

RELATED WORKS

- MUNIT
  - Divide information into content codes (Label), style codes (Else)



Number	z1
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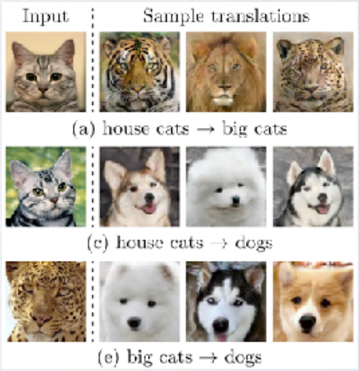
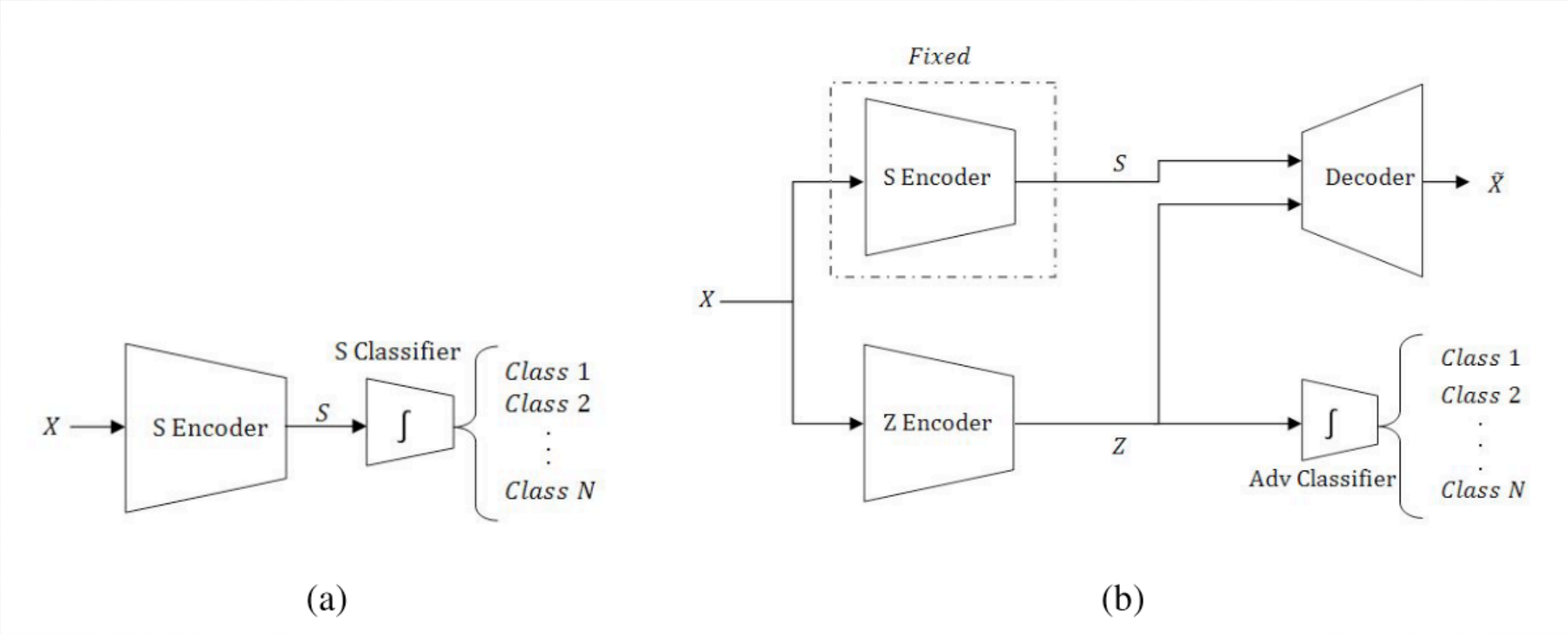
Style	z6



Source: Huang, Xun, et al. "Multimodal Unsupervised Image-to-Image Translation." *arXiv preprint arXiv:1804.04732* (2018).

A TWO-STEP DISENTANGLEMENT METHOD

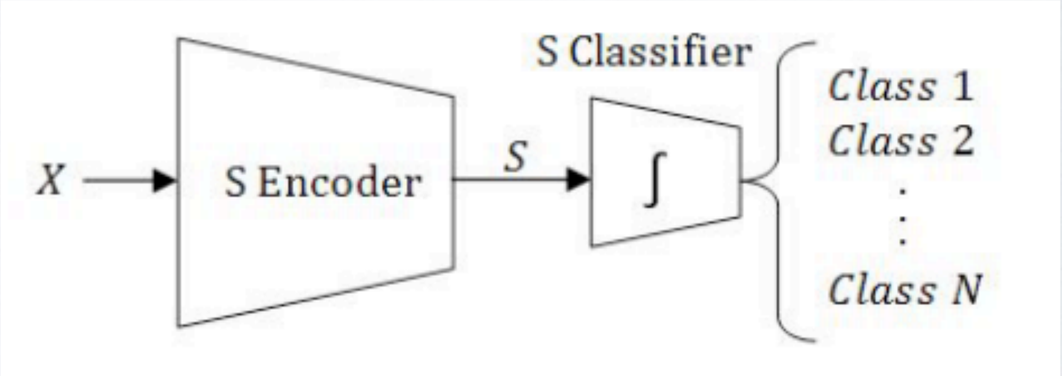
- Architecture



Source: Hadad, Naama, Lior Wolf, and Moni Shahar. "A Two-Step Disentanglement Method." *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*. 2018.

A TWO-STEP DISENTANGLEMENT METHOD

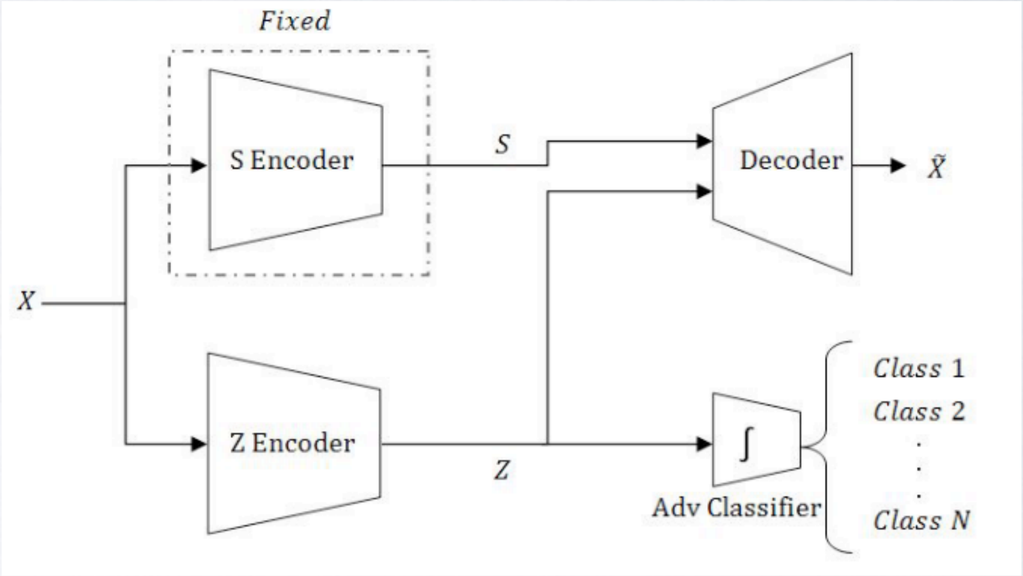
- The first step
  - Train a encoder and a classifier simultaneously
  - The encoder will only extract label discriminative features



A TWO-STEP DISENTANGLEMENT METHOD

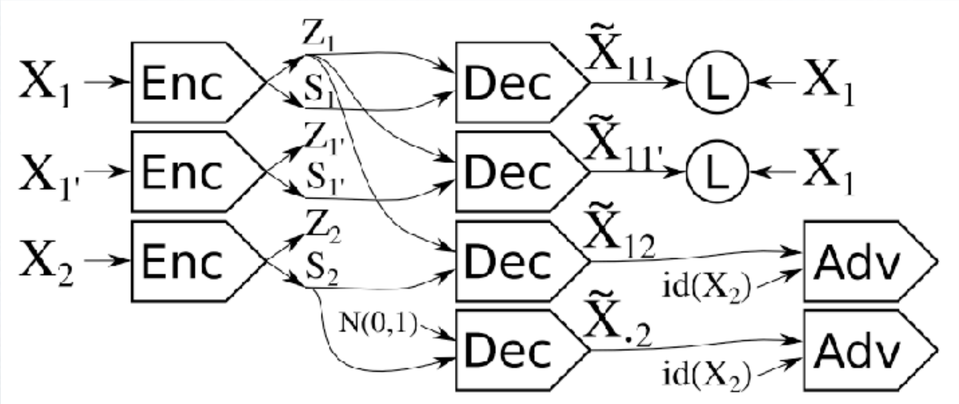
- The second step
  - Use encoder from the first step
  - Train another encoder to extract features other than label discriminative features features

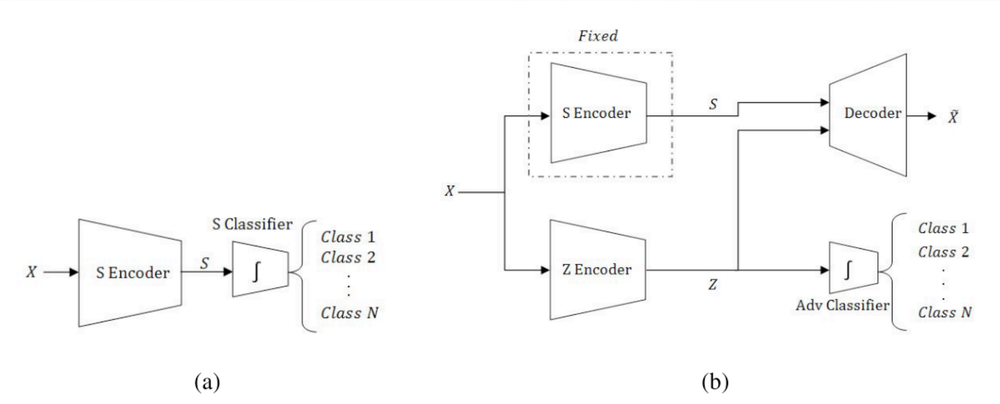
$$min_{\theta_Z,\theta_X} max_{\theta_A} \{L_{rec} - \lambda * L_{adv}\}, \lambda > 0$$



COMPARISON

- Toy data
  - Generated image with gray rectangle with 10 possible position and 2 color background (White / Black)
  - S(specified factor): Location
  - Z(unspecified factor): Background color

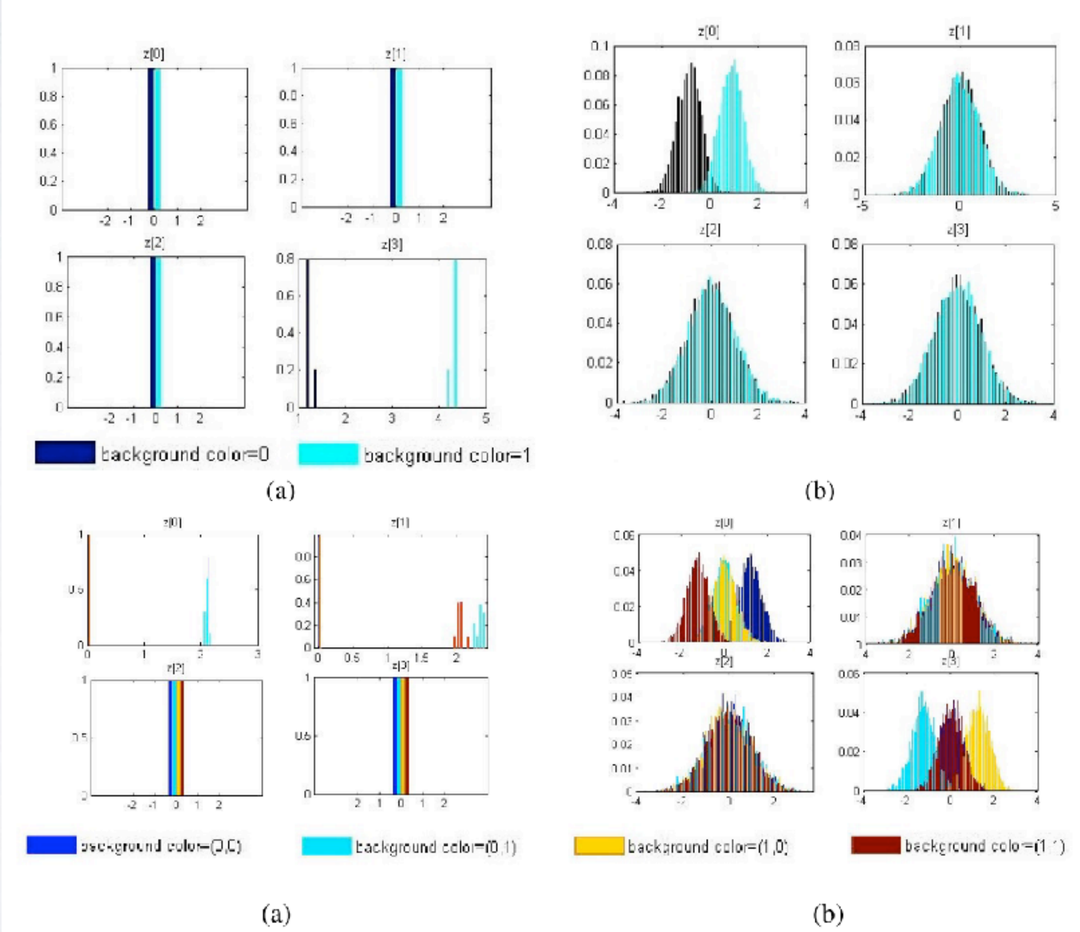




COMPARISON

- Results

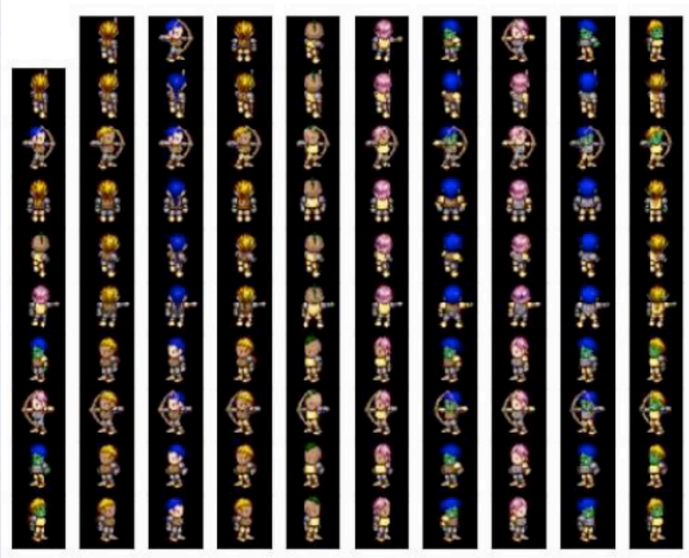
Proposed Model Comparison



EXPERIMENTS

- Image Benchmark
  - Swapping, Interpolation, Retrieval, Classification score
  - MNIST, NORB, Sprites, Extended-TaleB dataset

Swapping



Interpolation

Retrieval

EXPERIMENTS

- Financial Data
  - Goal: Separate market behavior from specific stock's movement
  - CAPM assumption - Security market line (SML)
    - $E[R] = Rf + \beta * (E[Rm] - Rf)$, $\beta = Cov(R, Rm)/Var(Rm)$
      - Rf - period risk free rate
      - Rm - market return vector, the day return
  - S(specified factor): Rf, Rm
  - Z(unspecified factor): β

EXPERIMENTS

- Financial Data
  - Daily returns of stocks listed in NASDAQ, NYSE, AMEX (1500 assets)

    Trained: 1976-2009, Test: 2010-2016, 63 trading days per quarter
  - Label: 34 years * 4 quarters = 136 periods
  - S length of 20, Z length of 50
  - Estimate β(Cov with Rm), ρ(Cov with Rm in last year) discretized into 4
  - Estimated volatility discretized into 4

RESULTS

- Estimating β, ρ

Table 4: Logistic regression accuracy for β, ρ

	beta	rho	beta [19]	rho [19]
Z	35%	31%	31%	30%
S	26%	26%	28%	28%
Raw	26%	26%		
Rand	25%	25%	25%	25%

- Estimating Volatility ρ

Table 6: Logistic regression accuracy for next day/week volatility. The rightmost column is the results of the model presented in [19]. Other columns are the results of our model.

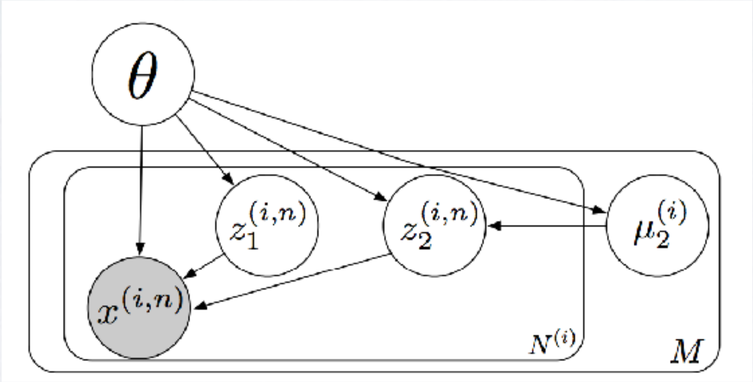
	NY	AM	NQ	All	[19]
Z-1	31%	37%	30%	31%	30%
S-1	26%	24%	24%	25%	27%
X-1	28%	24%	24%	— 25% —	
Rnd-1	——— 25% ———				
Z-5	40%	49%	36%	39%	34%
S-5	26%	27%	25%	26%	30%
X-5	25%	29%	25%	— 26% —	
Rnd-5	——— 25% ———				

Table 5: Options portfolio return. The mean, Std and percent of trading days with positive return

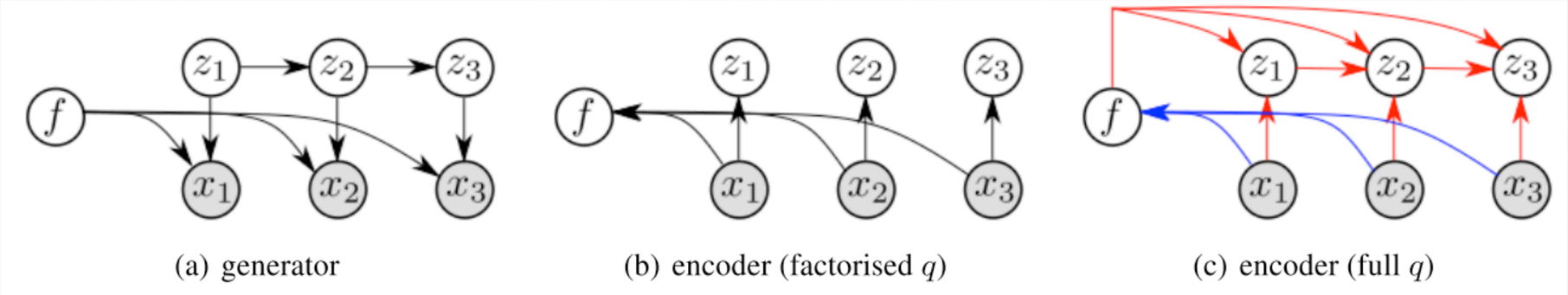
	Mean	SD	Traded days %
Z (Ours)	3.1%	0.026	89.3%
Z [19]	2.9%	0.039	78.6%
X	2.6%	0.030	78.6%

FUTURE WORKS

- FHVAE



- Disentangled Sequential Autoencoder



Source: Hsu, Wei-Ning, Yu Zhang, and James Glass. "Unsupervised learning of disentangled and interpretable representations from sequential data." *Advances in neural information processing systems*. 2017., Yingzhen, Li, and Stephan Mandt. "Disentangled Sequential Autoencoder." *International Conference on Machine Learning*. 2018.