Barlow Twin

Ⓕ Barlow twin

Batch of images x → y^A (Augmentation 1) ; y^B (Augmentation 2)

$z^A = f_\theta(y^A)$; $z^B = f_\theta(y^B)$ // mean centered.

$$\mathcal{L}_{BT} \triangleq \underbrace{\sum_i (1 - c_{ii})^2}_{\text{invariance term}} + \lambda \underbrace{\sum_i \sum_{j \neq i} c_{ij}^2}_{\text{redundancy reduction term}}$$

cross correlation matrix.

[proxy entropy]

where, $c_{ij} = \dfrac{\sum_b z^A_{bi} z^B_{bj}}{\sqrt{\sum_b (z^A_{bi})^2 \sum_b (z^B_{bj})^2}}$

→ b indexes batch sample

→ i, j vector dimension of the network.

↳ summation over all the samples.

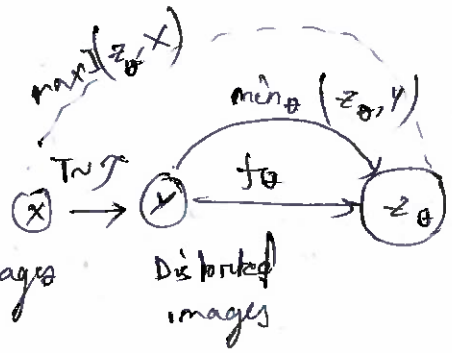
comparison with others:

$$\mathcal{L}_{\text{infoNCE}} \triangleq \underbrace{-\sum_b \frac{\langle z^A_b z^B_b \rangle_i}{\tau \|z^A_b\|_2 \|z^B_b\|_2}}_{\text{similarity term}} + \underbrace{\sum_b \log\left(\sum_{b' \neq b} \exp \frac{\langle z^A_b z^B_{b'} \rangle_i}{\tau \|z^A_b\| \|z^B_{b'}\|} \right)}_{\text{contrastive term.}}$$

non parametric estimation of Entropy of reps.

(F) Barlow twin (Appendix)

Information Bottleneck connection



$$IB_\theta \triangleq \underbrace{I(z_\theta, Y)}_{\text{close means invariant to } Y \text{ (Transformation)}} - \beta I(z_\theta, X) \qquad \text{As related to } X \text{ as possible.}$$

$$= \left[H(z_\theta) - H(z_\theta \mid Y)\right] \quad (H(z_\theta \mid Y) \to 0 \text{ (deterministic)})$$

$$- \beta \left[H(z_\theta) - H(z_\theta \mid X)\right]$$

(can be negative) the smaller the better.

β controlable

$$\approx H(z_\theta \mid X) + \underbrace{\frac{1-\beta}{\beta}}_{+ve} H(z_\theta) \quad \text{if } \beta = 1 \text{ // always positive}$$

then total positive (Entropy)

$z_\theta \sim$ gaussian constraints.

$$IB_\theta = E_X \log|C_{z_\theta|X}| + \frac{1-\beta}{\beta} \log|C_{z_\theta}|$$

($C_{z_\theta|X}$: covariance function; C_{z_θ}: covariance function)

connected to IB with some modification & constraints.