$$\text{sim}(z_i, z_j) = \frac{z_i \cdot z_j}{||z_i|| \, ||z_j||}$$

augmentation   representation   projection

$f(\cdot)$ $g(\cdot)$ sim

cosine similarity

$$l\,(i,j) = -\log \frac{\exp(\,\text{sim}(z_i, z_j)\,/\,\tau\,)}{\sum_{k=1}^{2N} \mathbf{1}_{k \neq i} \exp(\,\text{sim}(z_i, z_k)\,/\,\tau\,)} \qquad (1)$$

$$l\,(1,5) = -\log \frac{\exp(\blacksquare/\tau)}{\sum \exp(\square\square\blacksquare\square\square/\tau)}$$

$$l\,(5,1) = -\log \frac{\exp(\blacksquare/\tau)}{\sum \exp(\blacksquare\square\square\square\square/\tau)}$$

$$L = \frac{1}{2N} \sum_{k=1}^{N} [\; l(k, k+N) + l(k+N, k)\;] \qquad (2)$$

$$L = \frac{1}{2N} \sum_{k=1}^{2N} \left[-\log \frac{\exp(\blacksquare\blacksquare\blacksquare\blacksquare\blacksquare\blacksquare/\tau)}{\sum_{k=1}^{2N-1} \exp\left(\boxplus/\tau\right)} \right]$$

$$L = \frac{1}{2N} \sum_{k=1}^{2N} \left[-(\blacksquare\blacksquare\blacksquare\blacksquare\blacksquare\blacksquare/\tau) + \log\left(\sum_{k=1}^{2N-1} \exp\left(\boxplus/\tau\right)\right) \right]$$

loss