$XX^T.$

$\mathbb{E}XY^T \leq \mathbb{E}XX^T\mathbb{E}YY^T - \mathbb{E}XY^T$ is P.D.

$\cancel{\mathbb{E}\left[(X-\lambda Y)^T(X-\lambda Y)\right] \geq 0}$

as $\mathbb{E}(XY^T)_{ij} = \mathbb{E}\sum_k X_{ik}Y_{jk}.$

$\leq \sum_k \mathbb{E}X_{ik}^2\,\mathbb{E}Y_{jk}^2$

$\boxed{(\mathbb{E}X^TY)^2 \leq \mathbb{E}X^TX\,\mathbb{E}Y^TY.}$

$\mathbb{E}\left[X^TX - 2\lambda\mathbb{E}X^TY\right.$

$\cancel{\mathbb{E}\left[a^TXX^Ta\right] \geq 0}$

$\mathbb{E}\left[a^T(X-\lambda Y)(X-\lambda Y)^Ta\right] \geq 0 \quad \forall a.$

$\Rightarrow a^T\mathbb{E}XX^Ta - 2\lambda a^T\mathbb{E}XY^Ta + \lambda^2a^T\mathbb{E}YY^Ta \geq 0 \quad \forall a.$

$\Rightarrow \sqrt{4(a^T\mathbb{E}XY^Ta)^2 - 4a^T\mathbb{E}YY^Ta\,a^T\mathbb{E}XX^Ta}$

Dependent

two-D slices