1 Prerequisites

Characteristic Functions

2 Multivariate Central Limit Theorem

If $X_1, X_2, \ldots$ are i.i.d. random vectors in $\mathbb{R}^d$ with $\mathbb{E}X_i = \mu < \infty$ and finite covariance matrix $\Gamma$, then

$$n^{-1/2} \sum_{i=1}^{n} (X_i - \mu) \Rightarrow \chi$$

where $\chi$ is multivariate gaussian. That is,

$$\mathbb{E} \exp(i\theta \cdot \chi) = \exp\left(-\frac{1}{2} \sum_i \sum_j \theta_i \theta_j \Gamma_{i,j}\right).$$

3 Reference