The Kalman Filter

With Correlated Process and Observation Noise

System equation Observation equation	$\boldsymbol{x}_k = F_{k-1}\boldsymbol{x}_{k-1} + \boldsymbol{\epsilon}_{k-1}$ $\boldsymbol{\epsilon}_k \sim N(\boldsymbol{0}, \Sigma_{\epsilon,k})$ $\boldsymbol{b}_k = A_k\boldsymbol{x}_k + \boldsymbol{e}_k$ $\boldsymbol{e}_k \sim N(\boldsymbol{0}, \Sigma_{e,k})$
Initial conditions Other conditions	$E\{\boldsymbol{x}_0\} = \hat{\boldsymbol{x}}_0$ $E\{(\boldsymbol{x}_0 - \hat{\boldsymbol{x}}_{0\|0})(\boldsymbol{x}_0 - \hat{\boldsymbol{x}}_{0\|0})^\top\} = P_{0\|0}$ $E\{\boldsymbol{\epsilon}_k \boldsymbol{e}_j^\top\} = C_k,$ for all k, j
Prediction of state vector Prediction of covariance matrix	$\hat{\boldsymbol{x}}_{k\|k-1} = F_{k-1}\hat{\boldsymbol{x}}_{k-1\|k-1}$ $P_{k\|k-1} = F_{k-1}P_{k-1\|k-1}F_{k-1}^\top + \Sigma_{\epsilon,k}$
Kalman gain matrix Updating of state vector Covariance matrix for updating	$K_k = (P_{k\|k-1}A_k^\top + C_k)(A_k P_{k\|k-1}A_k^\top + \Sigma_{e,k} + A_k C_k + C_k^\top A_k^\top)^{-1}$ $\hat{\boldsymbol{x}}_{k\|k} = \hat{\boldsymbol{x}}_{k\|k-1} + K_k(\boldsymbol{b}_k - A_k\hat{\boldsymbol{x}}_{k\|k-1})$ $P_{k\|k} = (I - K_k A_k)P_{k\|k-1} - K_k C_k^\top$