Initialisation

$$\hat{\mathbf{x}}_0 = \mathbb{E}[\mathbf{x}_0], \mathbf{P}_0 = \mathbb{E}\left[(\mathbf{x}_0 - \hat{\mathbf{x}}_0)(\mathbf{x}_0 - \hat{\mathbf{x}}_0)^\mathsf{T}\right]$$

Time update

Compute a priori state estimate:

$$\hat{\mathbf{x}}_{k|k-1} = \boldsymbol{\phi}_{k-1}(\mathbf{x}_{k-1}, \mathbf{u}_{k-1})$$

Compute Jacobian matrix:

$$\boldsymbol{\Phi}_{k-1}^{[1]} = \left.\frac{\partial \boldsymbol{\phi}_{k-1}(\mathbf{x},\mathbf{u})}{\partial \mathbf{x}}\right|_{\mathbf{x}=\hat{\mathbf{x}}_{k-1},\mathbf{u}=\mathbf{u}_{k-1}}$$

Compute a priori error covariance:

$$\mathbf{P}_{k|k-1} = \boldsymbol{\Phi}_{k-1}^{[1]} \mathbf{P}_{k-1} \boldsymbol{\Phi}_{k-1}^{[1]\mathsf{T}} + \mathbf{Q}_{k-1}$$

Measurement update

Compute Jacobian matrix:

$$\mathbf{H}_k^{[1]} = \left.\frac{\partial \mathbf{h}_k(\mathbf{x})}{\partial \mathbf{x}}\right|_{\mathbf{x}=\hat{\mathbf{x}}_{k|k-1}}$$

Compute Kalman gain:

$$\mathbf{K}_k = \mathbf{P}_{k|k-1} \mathbf{H}_k^{[1]\mathsf{T}} \left(\mathbf{H}_k^{[1]} \mathbf{P}_{k|k-1} \mathbf{H}_k^{[1]\mathsf{T}} + \mathbf{R}_k\right)^{-1}$$

Compute a posteriori state estimate:

$$\hat{\mathbf{x}}_k = \hat{\mathbf{x}}_{k|k-1} + \mathbf{K}_k\left(\mathbf{z}_k - \mathbf{h}_k(\hat{\mathbf{x}}_{k|k-1})\right)$$

Update error covariance:

$$\mathbf{P}_k = \left(\mathbf{I}_n - \mathbf{K}_k \mathbf{H}_k^{[1]}\right) \mathbf{P}_{k|k-1}$$

Output