*Initialisation*

$$\hat{\mathbf{x}}_0^a = \left[\hat{\mathbf{x}}_0^\mathsf{T}, \mathbb{E}\left[\boldsymbol{w}_0{}^\mathsf{T}\right], \mathbb{E}\left[\boldsymbol{v}_0{}^\mathsf{T}\right]\right]^\mathsf{T}$$

$$\mathbf{P}_0^a = \mathbb{E}\left[\left(\mathbf{x}_0^a - \hat{\mathbf{x}}_0^a\right)\left(\mathbf{x}_0^a - \hat{\mathbf{x}}_0^a\right)^\mathsf{T}\right] = \begin{bmatrix} \mathbf{P}_0 & 0 & 0 \\ 0 & \mathbf{Q}_0 & 0 \\ 0 & 0 & \mathbf{R}_0 \end{bmatrix}$$

*Calculation of sigma points*

$$\mathcal{X}_{k-1}^a = \left\{\hat{\mathbf{x}}_{k-1}^a, \quad \hat{\mathbf{x}}_{k-1}^a + \gamma_a \sqrt{\mathbf{P}_{k-1}^a}, \quad \hat{\mathbf{x}}_{k-1}^a - \gamma_a \sqrt{\mathbf{P}_{k-1}^a}\right\}$$

*Time update*

Propagate sigma points:

$$\mathcal{X}_{k|k-1}^x = \boldsymbol{\phi}_{k-1}\left(\mathcal{X}_{k-1}^x, \mathbf{u}_{k-1}, \mathcal{X}_{k-1}^w\right)$$

Compute a priori state estimate:

$$\hat{\mathbf{x}}_{k|k-1} = \sum_{i=0}^{2l} W_i^{(m)} \mathcal{X}_{i,k|k-1}^x$$

Compute a priori error covariance:

$$\mathbf{P}_{k|k-1} = \sum_{i=0}^{2l} W_i^{(c)} \left(\mathcal{X}_{i,k|k-1}^x - \hat{\mathbf{x}}_{k|k-1}\right)\left(\mathcal{X}_{i,k|k-1}^x - \hat{\mathbf{x}}_{k|k-1}\right)^\mathsf{T}$$

Predict measurement:

$$\mathcal{Z}_{k|k-1} = \mathbf{h}_k\left(\mathcal{X}_{k|k-1}^x, \mathcal{X}_{k|k-1}^v\right)$$

$$\hat{\boldsymbol{z}}_{k|k-1} = \sum_{i=0}^{2l} W_i^{(m)} \mathcal{Z}_{i,k|k-1}$$

*Measurement update*

Compute innovation and cross covariance matrix:

$$\mathbf{P}_{\tilde{z}_k \tilde{z}_k} = \sum_{i=0}^{2l} W_i^{(c)} \left(\mathcal{Z}_{i,k|k-1} - \hat{\boldsymbol{z}}_{k|k-1}\right)\left(\mathcal{Z}_{i,k|k-1} - \hat{\boldsymbol{z}}_{k|k-1}\right)^\mathsf{T}$$

$$\mathbf{P}_{\tilde{x}_k \tilde{z}_k} = \sum_{i=0}^{2l} W_i^{(c)} \left(\mathcal{X}_{i,k|k-1}^x - \hat{\mathbf{x}}_{k|k-1}\right)\left(\mathcal{Z}_{i,k|k-1} - \hat{\boldsymbol{z}}_{k|k-1}\right)^\mathsf{T}$$

Compute Kalman gain:

$$\mathcal{K}_k = \mathbf{P}_{\tilde{x}_k \tilde{z}_k} \mathbf{P}_{z_k z_k}^{-1}$$

Compute a posteriori state estimate:

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

Update error covariance:

$$\mathbf{P}_k = \mathbf{P}_{k|k-1} - \mathcal{K}_k \mathbf{P}_{\tilde{z}_k \tilde{z}_k} \mathcal{K}_k^\mathsf{T}$$

Output