Initialisation

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

Calculation of sigma points

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

Time update

Propagate sigma points:

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

Compute a priori state estimate:

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

Compute a priori error covariance:

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

Predict measurement:

$$\mathcal{Z}_{k|k-1} = \mathbf{h}_k(\mathcal{X}_{k|k-1})$$

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

Measurement update

Compute innovation and cross covariance matrix:

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

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

Compute Kalman gain:

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

Compute a posteriori state estimate:

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

Update error covariance:

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

Output