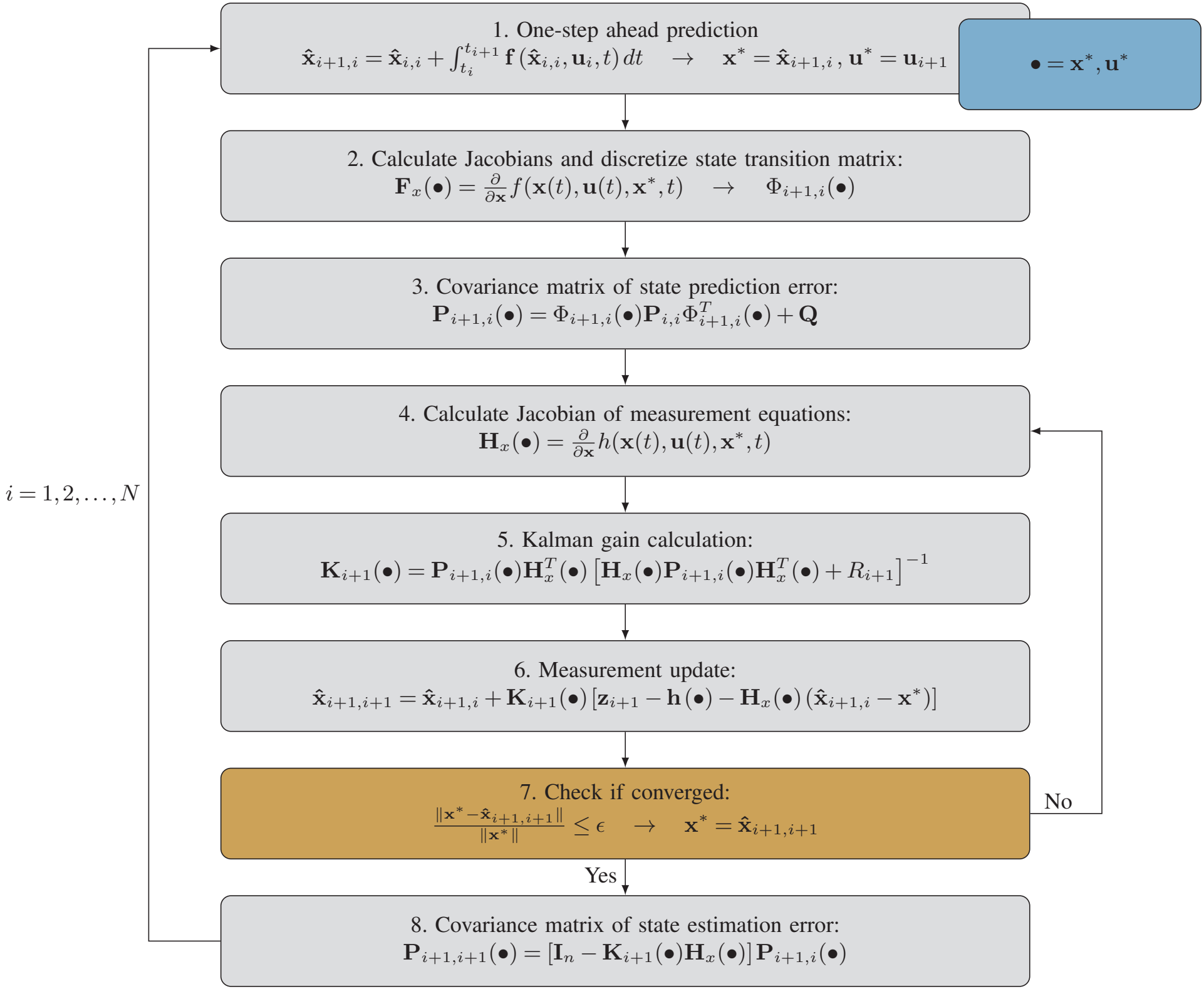
1. One-step ahead prediction
$\hat{\mathbf{x}}_{i+1,i} = \hat{\mathbf{x}}_{i,i} + \int_{t_i}^{t_{i+1}} \mathbf{f}\left(\hat{\mathbf{x}}_{i,i}, \mathbf{u}_i, t\right) dt \quad \rightarrow \quad \mathbf{x}^* = \hat{\mathbf{x}}_{i+1,i}\,,\ \mathbf{u}^* = \mathbf{u}_{i+1}$
$\bullet = \mathbf{x}^*, \mathbf{u}^*$
2. Calculate Jacobians and discretize state transition matrix:
$\mathbf{F}_x(\bullet) = \frac{\partial}{\partial \mathbf{x}} f(\mathbf{x}(t), \mathbf{u}(t), \mathbf{x}^*, t) \quad \rightarrow \quad \Phi_{i+1,i}(\bullet)$
3. Covariance matrix of state prediction error:
$\mathbf{P}_{i+1,i}(\bullet) = \Phi_{i+1,i}(\bullet)\mathbf{P}_{i,i}\Phi_{i+1,i}^T(\bullet) + \mathbf{Q}$
4. Calculate Jacobian of measurement equations:
$\mathbf{H}_x(\bullet) = \frac{\partial}{\partial \mathbf{x}} h(\mathbf{x}(t), \mathbf{u}(t), \mathbf{x}^*, t)$
$i = 1, 2, \ldots, N$
5. Kalman gain calculation:
$\mathbf{K}_{i+1}(\bullet) = \mathbf{P}_{i+1,i}(\bullet)\mathbf{H}_x^T(\bullet)\left[\mathbf{H}_x(\bullet)\mathbf{P}_{i+1,i}(\bullet)\mathbf{H}_x^T(\bullet) + R_{i+1}\right]^{-1}$
6. Measurement update:
$\hat{\mathbf{x}}_{i+1,i+1} = \hat{\mathbf{x}}_{i+1,i} + \mathbf{K}_{i+1}(\bullet)\left[\mathbf{z}_{i+1} - \mathbf{h}(\bullet) - \mathbf{H}_x(\bullet)\left(\hat{\mathbf{x}}_{i+1,i} - \mathbf{x}^*\right)\right]$
7. Check if converged:
$\frac{\|\mathbf{x}^* - \hat{\mathbf{x}}_{i+1,i+1}\|}{\|\mathbf{x}^*\|} \leq \epsilon \quad \rightarrow \quad \mathbf{x}^* = \hat{\mathbf{x}}_{i+1,i+1}$
No
Yes
8. Covariance matrix of state estimation error:
$\mathbf{P}_{i+1,i+1}(\bullet) = \left[\mathbf{I}_n - \mathbf{K}_{i+1}(\bullet)\mathbf{H}_x(\bullet)\right]\mathbf{P}_{i+1,i}(\bullet)$