

状態方程式

$$x_{t/t-1} = Fx_{t-1/t-1} + Gu_{t-1}$$

観測方程式

$$z_{t/t-1} = Hx_{t/t-1}$$

$$R_{t/t-1} = HP_{t/t-1}H^T$$

$x_t$  の分散共分散行列

$$\begin{aligned} P_{t/t-1} &= E[\Delta x_{t/t-1}^2] \\ &= E[(F\Delta x_{t-1/t-1} + G\Delta u_{t-1})^2] \\ &= F^2 E[\Delta x_{t-1/t-1}^2] + 2E[F\Delta x_{t-1/t-1}G\Delta u_{t-1}] + G^2 E[\Delta u_{t-1}^2] \\ &= F^2 E[\Delta x_{t-1/t-1}^2] + G^2 E[\Delta u_{t-1}^2] \\ &= F^2 P_{t-1/t-1} + G^2 Q_{t-1} \end{aligned}$$

計測更新

$$z_{t/t} = w_1 z_{t/t-1} + w_2 z_t$$

計測更新: 分散

$$\begin{aligned} \sigma^2 &= E[\Delta z_{t/t}^2] \\ &= w_1^2 R_{t/t-1} + w_2^2 R_t \end{aligned}$$

最小分散推定

$$\frac{\partial \sigma^2}{\partial w_1} = \frac{\partial}{\partial w_1} \{w_1^2 R_{t/t-1} + (1 - w_1)^2 R_t\} = 0$$

$$w_1 = \frac{R_t}{R_{t/t-1} + R_t}, \quad w_2 = \frac{R_{t/t-1}}{R_{t/t-1} + R_t}$$

計測更新: 状態の更新

$$\begin{aligned} z_{t/t} &= w_1 z_{t/t-1} + w_2 z_t \\ &= \frac{R_t}{R_{t/t-1} + R_t} z_{t/t-1} + \frac{R_{t/t-1}}{R_{t/t-1} + R_t} z_t \\ &= z_{t/t-1} + \frac{R_{t/t-1}}{R_{t/t-1} + R_t} (z_t - z_{t/t-1}) \end{aligned}$$

$$Hx_{t/t} = Hx_{t/t-1} + \frac{HP_{t/t-1}H^T}{HP_{t/t-1}H^T + R_t} (z_t - z_{t/t-1})$$

$$x_{t/t} = x_{t/t-1} + \frac{P_{t/t-1}H^T}{HP_{t/t-1}H^T + R_t} (z_t - z_{t/t-1})$$

カルマンフィルタ: 計測更新

$$\tilde{z} = z_t - z_{t/t-1}$$

$$S = H^2 P_{t/t-1} + R_t$$

$$K = H P_{t/t-1} S^{-1}$$