

Autonomous robot: Docking Robot

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I. FORMALIZATION

First, we will formalize the different equations of the problem:

A. Estimation motion

$$\begin{aligned}p(X_t = is_docked|U_t = DOCK_INTO_STATION, X_{t-1} = is_docked) &= 0.9 \\p(X_t = is_not_docked|U_t = DOCK_INTO_STATION, X_{t-1} = is_docked) &= 0.1 \\p(X_t = is_docked|U_t = DOCK_INTO_STATION, X_{t-1} = is_not_docked) &= 0.8 \\p(X_t = is_not_docked|U_t = DOCK_INTO_STATION, X_{t-1} = is_not_docked) &= 0.2\end{aligned}$$

B. Measurement

$$\begin{aligned}p(Z_t = ROBOT_IS_DOCKED|X_t = is_docked) &= 0.7 \\p(Z_t = ROBOT_IS_DOCKED|X_t = is_not_docked) &= 0.3 \\p(Z_t = ROBOT_IS_NOT_DOCKED|X_t = is_not_docked) &= 0.6 \\p(Z_t = ROBOT_IS_NOT_DOCKED|X_t = is_docked) &= 0.4\end{aligned}$$

II. APPLICATION

A. Prior belief

$$\begin{aligned}\bar{b}ef(is_docked) &= p(X_1 = is_docked|U_t = DOCK_INTO_STATION, X_0 = is_docked) \times (X_0 = is_docked) + \\p(X_1 = is_docked|U_t = DOCK_INTO_STATION, X_0 = is_not_docked) \times (X_0 = is_not_docked) &= \\0.9 \times 0.5 + 0.8 \times 0.5 &= 0.85 \\ \bar{b}ef(is_not_docked) &= p(X_1 = is_not_docked|U_t = DOCK_INTO_STATION, X_0 = is_docked) \times (X_0 = \\is_docked) + p(X_1 = is_not_docked|U_t = DOCK_INTO_STATION, X_0 = is_not_docked) \times (X_0 = & \\is_not_docked) &= 0.1 \times 0.5 + 0.2 \times 0.5 = 0.15\end{aligned}$$

B. Update and belief

$$\begin{aligned}bel(X_1 = is_docked) &= \eta \times p(Z_1 = ROBOT_IS_DOCKED|X_1 = is_docked) \times \bar{b}ef(is_docked) = \\ \eta \times 0.85 \times 0.7 &= \eta \times 0.595 \\ bel(X_1 = is_not_docked) &= \eta \times p(Z_1 = ROBOT_IS_NOT_DOCKED|X_1 = is_docked) \times \bar{b}ef(is_not_docked) = \\ \eta \times 0.15 \times 0.4 &= \eta \times 0.06 \\ \eta &= \frac{1}{0.595+0.06} = 1.5267 \\ \text{Hence, } bel(X_1 = is_docked) &= 0.9084 \\ bel(X_1 = is_not_docked) &= 0.0916\end{aligned}$$