Autonomous robot: Docking Robot

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I. Formalization

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

A. Estimation motion

$p(X_t = is\_docked|U_t = DOCK\_INTO\_STATION, X_{t-1} = is\_docked) = 0.9$
$p(X_t = is\_not\_docked|U_t = DOCK\_INTO\_STATION, X_{t-1} = is\_docked) = 0.1$
$p(X_t = is\_docked|U_t = DOCK\_INTO\_STATION, X_{t-1} = is\_not\_docked) = 0.8$
$p(X_t = is\_not\_docked|U_t = DOCK\_INTO\_STATION, X_{t-1} = is\_not\_docked) = 0.2$

B. Measurement

$p(Z_t = ROBOT\_IS\_DOCKED|X_t = is\_docked) = 0.7$
$p(Z_t = ROBOT\_IS\_DOCKED|X_t = is\_not\_docked) = 0.3$
$p(Z_t = ROBOT\_IS\_NOT\_DOCKED|X_t = is\_not\_docked) = 0.6$
$p(Z_t = ROBOT\_IS\_NOT\_DOCKED|X_t = is\_docked) = 0.4$

II. Application

A. Prior belief

$\bar{bel}(is\_docked) = p(X_1 = is\_docked|U_t = DOCK\_INTO\_STATION, X_0 = is\_docked) \times (X_0 = is\_docked) +$
$p(X_1 = is\_docked|U_t = DOCK\_INTO\_STATION, X_0 = is\_not\_docked) \times (X_0 = is\_not\_docked) =$
$0.9 \times 0.5 + 0.8 \times 0.5 = 0.85$
$\bar{bel}(is\_not\_docked) = p(X_1 = is\_not\_docked|U_t = DOCK\_INTO\_STATION, X_0 = is\_docked) \times (X_0 =$
$is\_docked) + p(X_1 = is\_not\_docked|U_t = DOCK\_INTO\_STATION, X_0 = is\_not\_docked) \times (X_0 =$
$is\_not\_docked) = 0.1 \times 0.5 + 0.2 \times 0.5 = 0.15$

B. Update and belief

$bel(X1 = is\_docked) = \eta \times p(Z1 = ROBOT\_IS\_DOCKED|X_1 = is\_docked) \times \bar{bel}(is\_docked) =$
$\eta \times 0.85 \times 0.7 = \eta \times 0.595$
$bel(X1 = is\_not\_docked) = \eta \times p(Z1 = ROBOT\_IS\_NOT\_DOCKED|X_1 = is\_docked) \times \bar{bel}(is\_not\_docked) =$
$\eta \times 0.15 \times 0.4 = \eta \times 0.06$
$\eta = \frac{1}{0.595+0.06} = 1.5267$
Hence, $bel(X1 = is\_docked) = 0.9084$
$bel(X1 = is\_not\_docked) = 0.0916$