

# 1D motion estimation via sensors

## SOLUTION (car on a straight road)

$$\begin{cases} \dot{x} = v \\ \dot{v} = a \\ \dot{a} = 0 + w_a \end{cases} \Rightarrow \underbrace{\begin{bmatrix} x \\ v \\ a \end{bmatrix}}_{\mathbf{x}} = \underbrace{\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}}_{\mathbf{F}} \underbrace{\begin{bmatrix} x \\ v \\ a \end{bmatrix}}_{\mathbf{x}} + \underbrace{\begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}}_{\mathbf{G}} \underbrace{\begin{bmatrix} w_a \\ \mathbf{w} \end{bmatrix}}_{\mathbf{w}}$$

$$\begin{cases} z_1 = x + v_1 \\ z_2 = \omega_w + v_2 = \frac{v}{r} + v_2 \end{cases} \Rightarrow \underbrace{\begin{bmatrix} z_1 \\ z_2 \end{bmatrix}}_{\mathbf{z}} = \underbrace{\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1/r & 0 \end{bmatrix}}_{\mathbf{H}} \underbrace{\begin{bmatrix} x \\ v \\ a \end{bmatrix}}_{\mathbf{x}} + \underbrace{\begin{bmatrix} v_1 \\ v_2 \end{bmatrix}}_{\mathbf{v}}$$