Kalman Filter

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Low-pass Filter in Time

New data $x_k$ comes in

$$\bar{x}_k = \frac{x_1 + x_2 + \cdots + x_{k-1} + x_k}{k}$$

Recursive

$$\bar{x}_k = \frac{k-1}{k} \bar{x}_{k-1} + \frac{1}{k} x_k$$

$$= \alpha \bar{x}_{k-1} + (1 - \alpha)x_k, \quad \alpha = \frac{k-1}{k}$$
Sensor Fusion (Two Measured Observations)
Kalman Filter

• Linear dynamical system of motion

• $A, B, C$?

• Continuous State space model
  – For filtering and control applications
  – Linear-Gaussian state space model
  – Widely used in many applications:
    • GPS, weather systems, etc.

• Weakness
  – Linear state space model assumed
  – Difficult to apply to highly non-linear domains

\[
\begin{align*}
x_{t+1} &= A x_t + B u_t \\
z_t &= C x_t
\end{align*}
\]