

# Thoughts about Generative Models in Control Systems



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- ▶ Control and estimation methods usually start with a dynamical system model of the form

$$x(k+1) = f(x(k), u(k), w(k)),$$

where

- ▶  $x$  is what we call the *state*
  - ▶  $u$  is what we call the *control*
  - ▶  $w$  is what we call the *process noise*
- 
- ▶ Usual assumptions include:
    - ▶  $x(k) \in \mathbb{R}^n$ ,  $u(k) \in \mathbb{R}^m$ , where  $n, m$  are “small”  $\sim 10$
    - ▶  $f$  is known, e.g., from physics
    - ▶  $w$  is a white noise process, i.e.,  $w(k) \sim N(0, Q)$  and  $w(k), w(\ell)$  are uncorrelated

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where

- ▶  $x$  is what we call the state
  - ▶  $u$  is what we call the control
  - ▶  $w$  is what we call the process noise
- ▶ Let us call this the *believed model*  
(to distinguish from other “models” that come up)

- ▶ The real system evolves *close to*, but not *exactly* according to the believed model.  
Examples:
- ▶  $f$  is slightly different, e.g., has some extra terms due to simplified physics
- ▶  $w$  is not white noise
- ▶ There are extra (hidden) states, e.g., actuator dynamics

- We are usually interested in the conditional distribution  $p(x(k+1) | x(k), u(k))$  for designing estimators or controllers (esp. RL-based controllers)