CS 4610/5335 – Lecture 10
Kalman Filtering (n-D)

Lawson L.S. Wong
Northeastern University
2/23/22

Material adapted from:
1. Robert Platt, CS 4610/5335
2. Sebastian Thrun, Wolfram Burgard, & Dieter Fox,
   Probabilistic Robotics

Announcements

Friday OH slightly shifted this week: 3 – 5 PM

Ex2 due Friday (2/25)

Ex3 will be out ~Fri/Sat

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Project: Continue adding details to your threads
- We will review them in the next week
  and possibly leave comments / questions

- Craft a two-month plan
  (lay out a weekly/biweekly plan; 10 weeks left)
- Starting work in simulation is highly recommended
  (plan for hardware to arrive mid-/late March)

Robotics talk of interest!

Tesca Fitzgerald
Postdoctoral Fellow
Robotics Institute, CMU

Learning to address novel situations
through human-robot collaboration

Friday, February 25
10:30 – 11:30 AM
366 West Village H
also on Zoom: 950 4773 0161 (423306)

"My research is centered around interactive robot learning.
… I develop algorithms that allow a robot to structure and interpret its interactions with a human teacher in order to adapt its task knowledge to novel situations.
… My work contributes toward a future of adaptive, collaborative robots."

Outline

Kalman filter (1-D, simplified) + example

Derivation of 1-D Kalman filter

Kalman filter (1-D, general) + example

Kalman filter (n-D) + example (time-permitting)

Recap: Localization example (1-D)

From “Probabilistic Robotics” (Ch. 7-8)
by Sebastian Thrun, Wolfram Burgard, & Dieter Fox

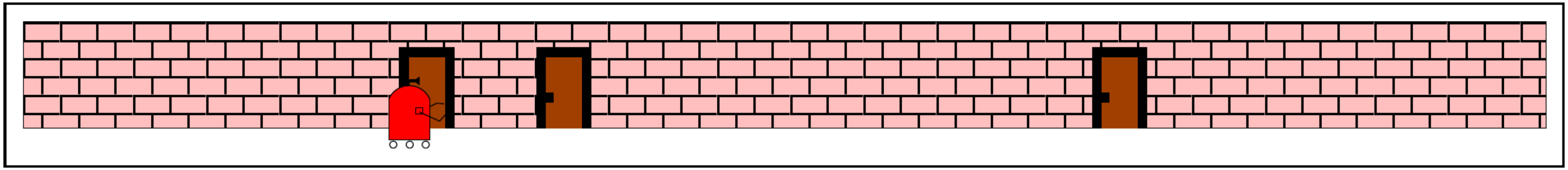

Figure 7.4 Example environment used to illustrate mobile robot localization: One-dimensional hallway environment with three indistinguishable doors. Initially the robot does not know its location except for its heading direction. Its goal is to find out where it is.

Recap: Localization example (1-D)

From
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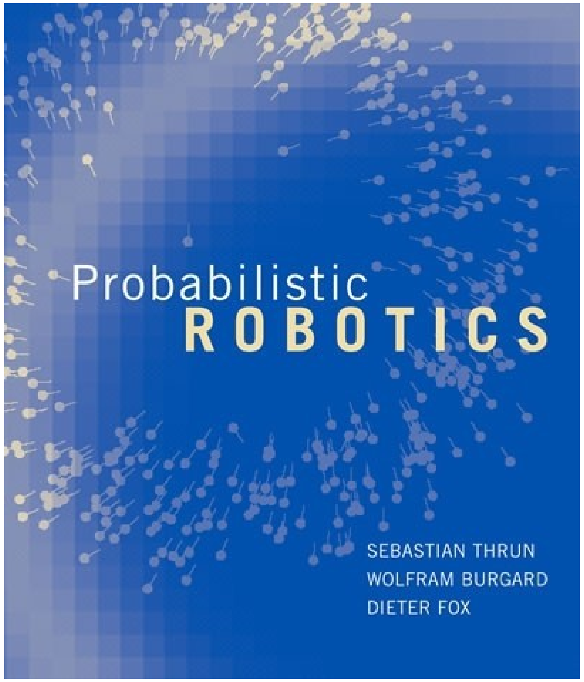


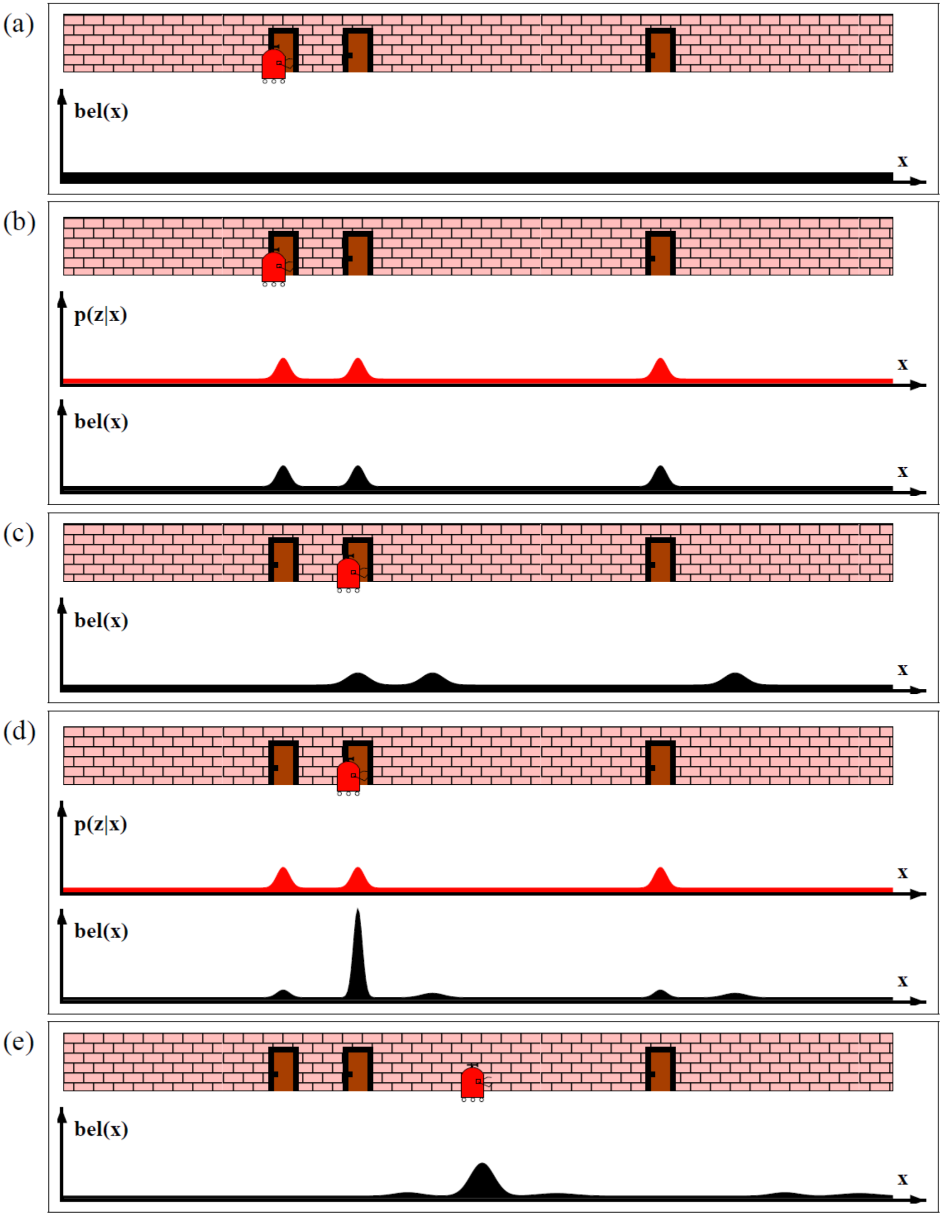


Figure 7.4 Illustration of the Markov localization algorithm. Each picture depicts the position of the robot in the hallway and its current belief $bel(x)$. (b) and (d) additionally depict the observation model $p(z_t \mid x_t)$, which describes the probability of observing a door at the different locations in the hallway.

Recap: Kalman Filter (1-D)

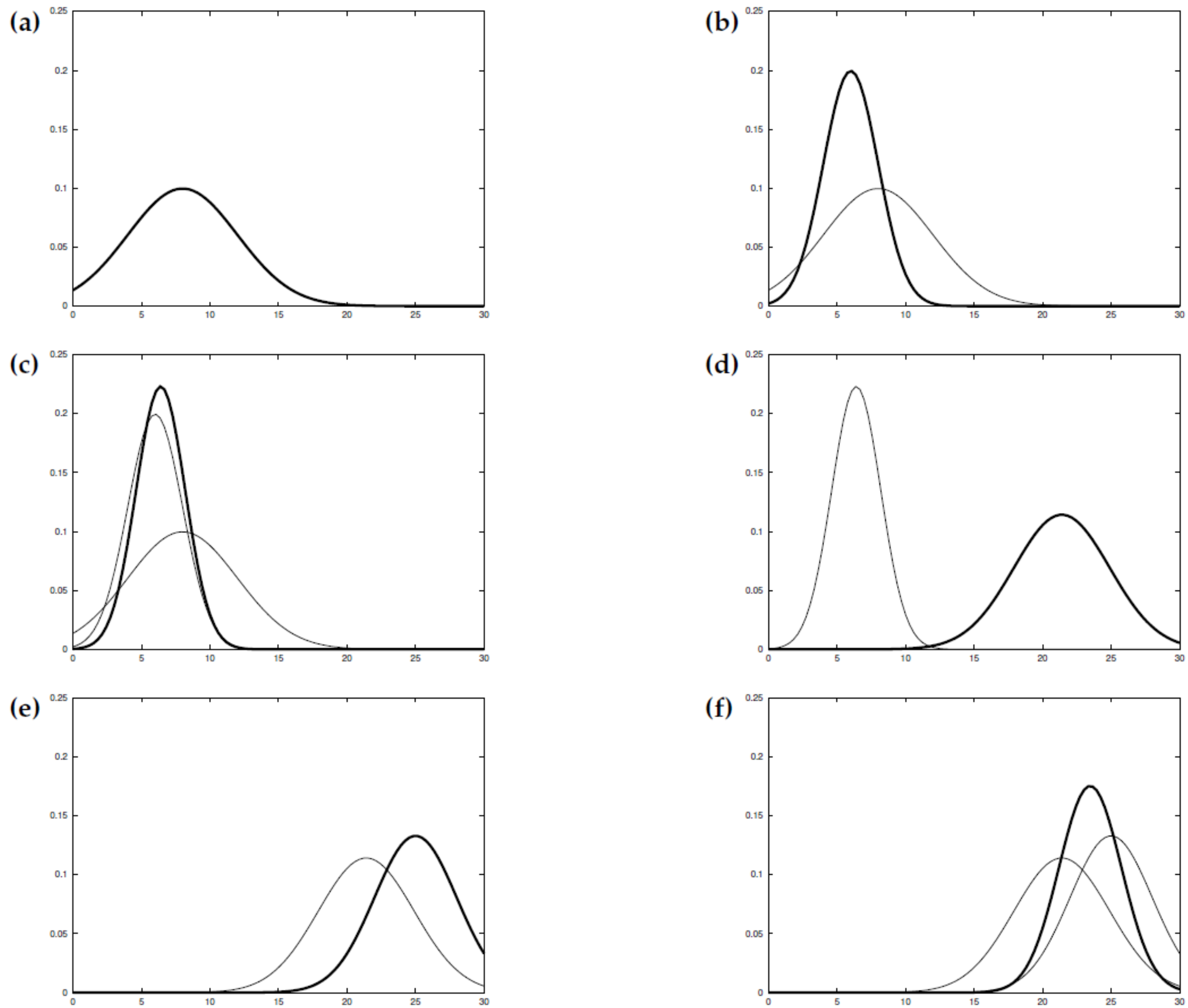
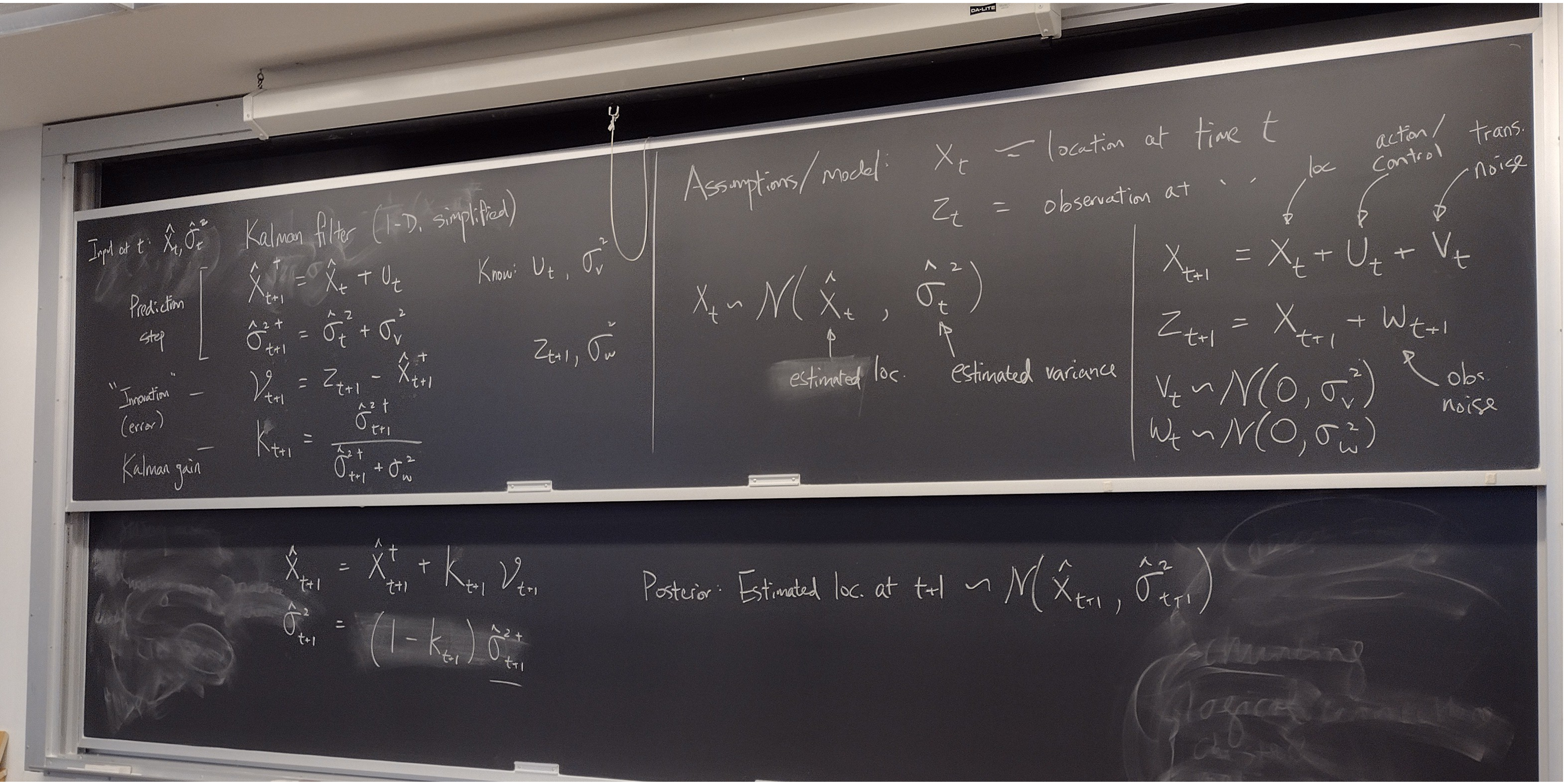


Figure 3.2 Illustration of Kalman filters: (a) initial belief, (b) a measurement (in bold) with the associated uncertainty, (c) belief after integrating the measurement into the belief using the Kalman filter algorithm, (d) belief after motion to the right (which introduces uncertainty), (e) a new measurement with associated uncertainty, and (f) the resulting belief.

On the board: 1-D Kalman Filter (simplified)



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✔ Kalman filter (1-D, simplified) + example

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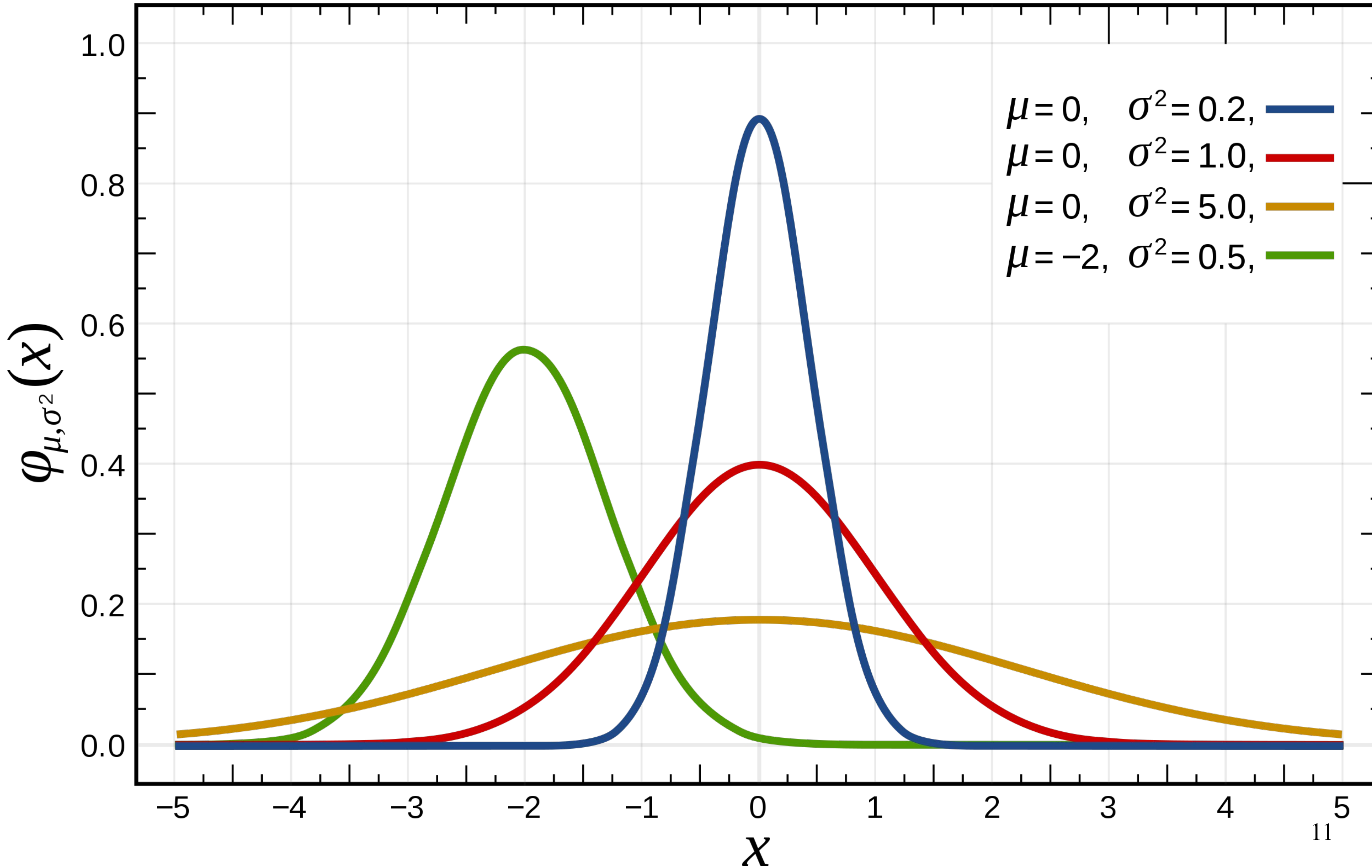
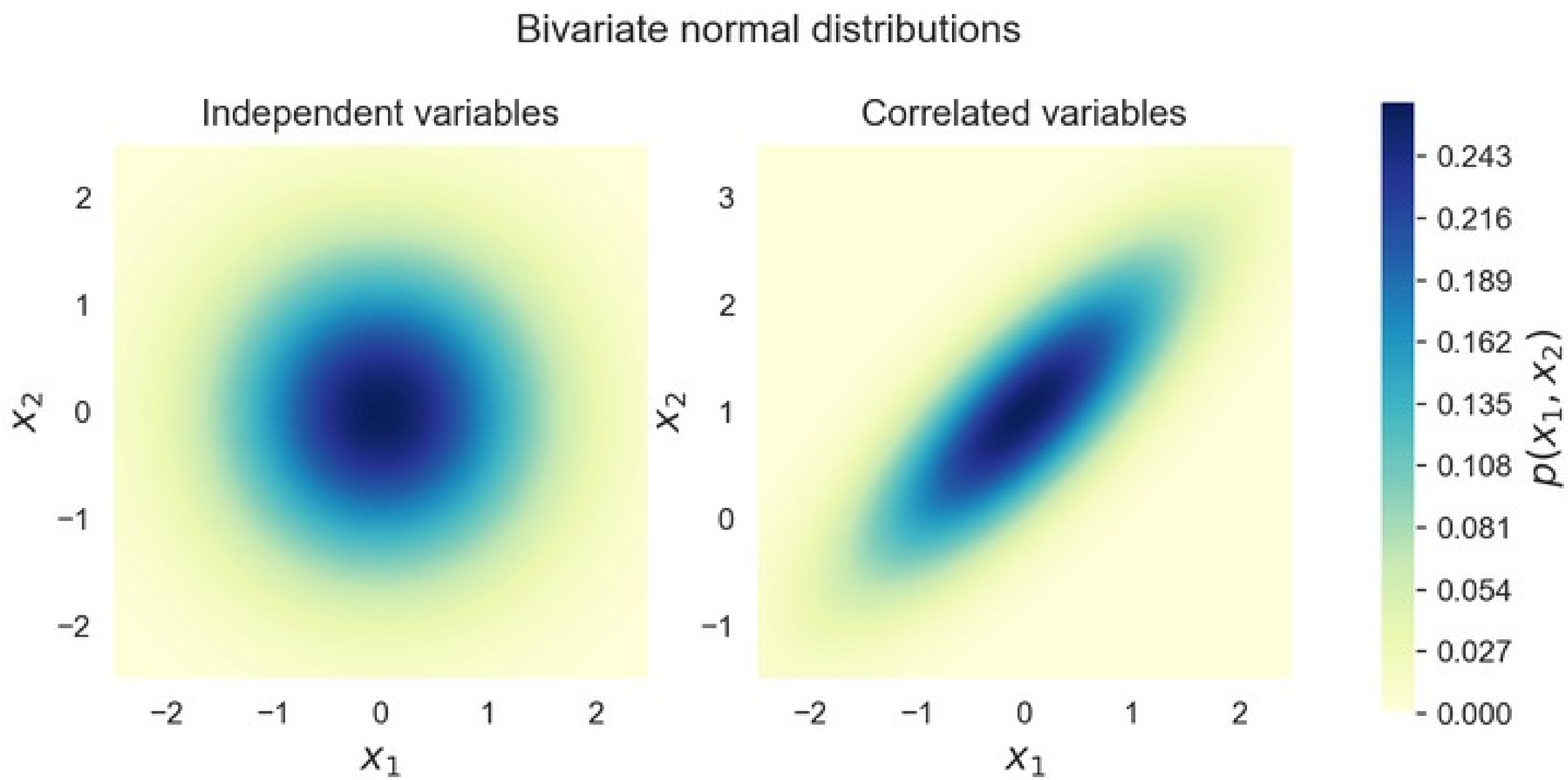
Kalman filter (1-D, general) + example

Kalman filter (n-D) + example (time-permitting)

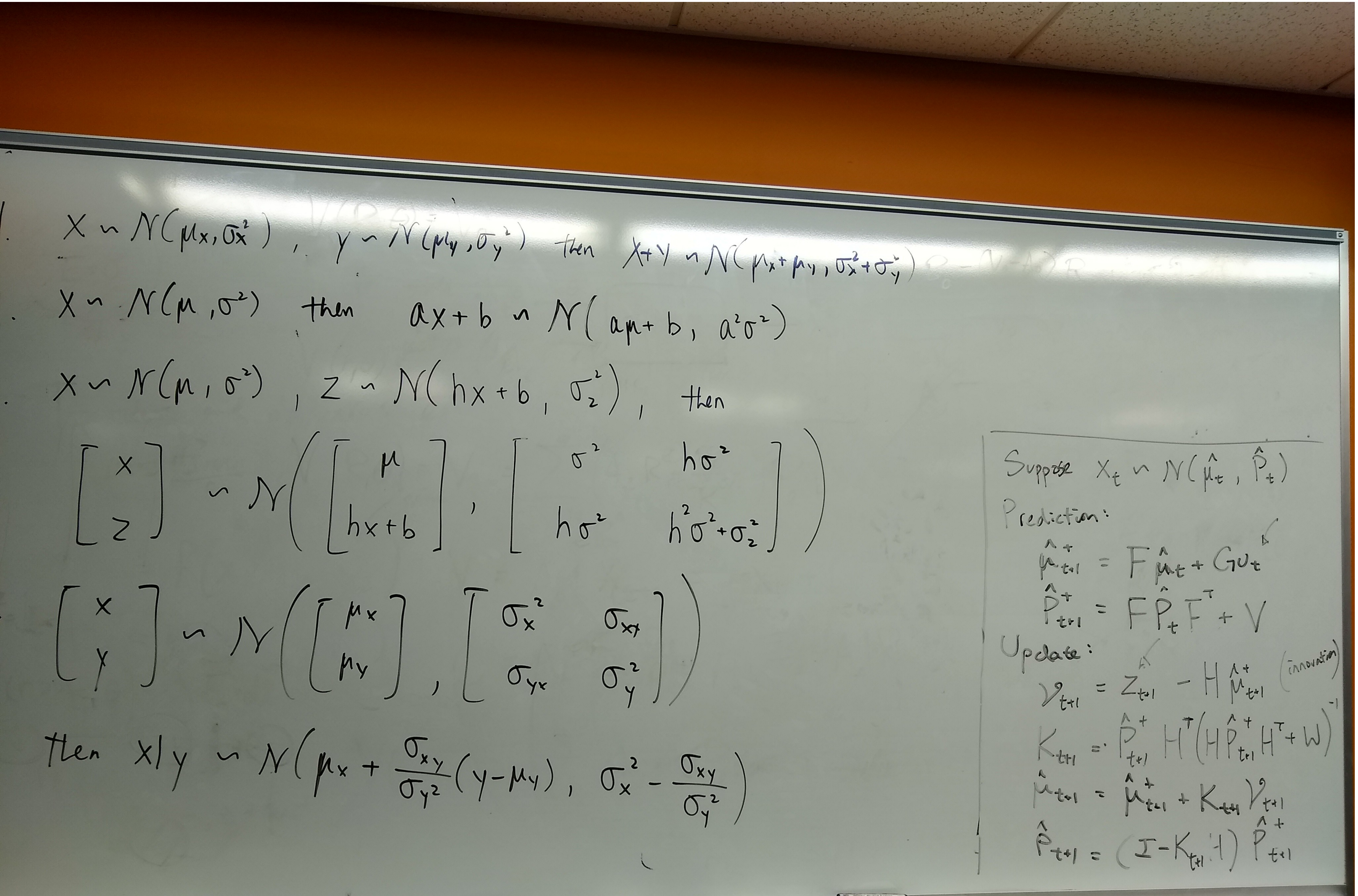
Gaussian distribution / Normal distribution (1-D)



Gaussian distribution / Normal distribution (2-D)



On the board: Properties of Gaussian distributions



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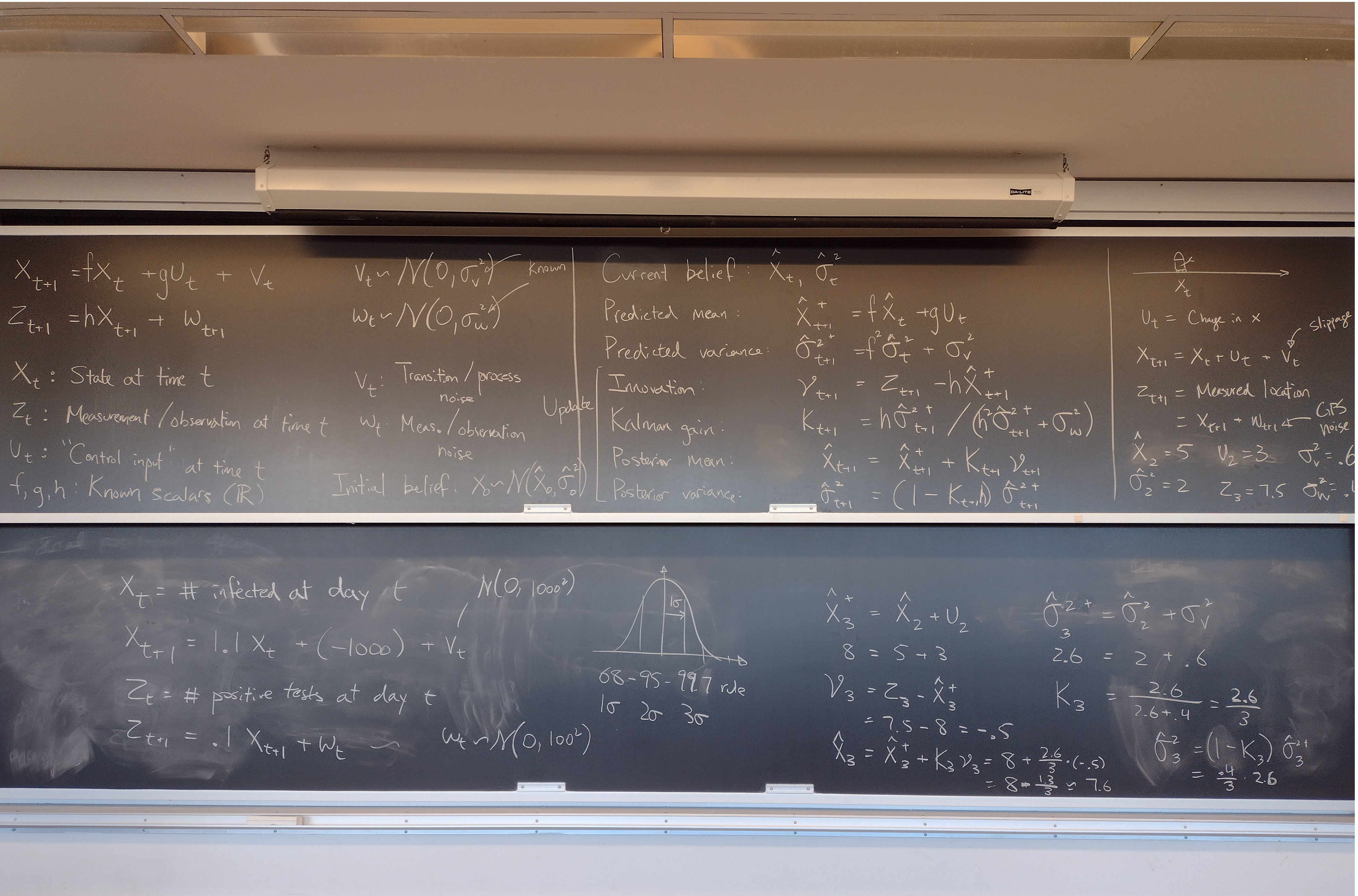
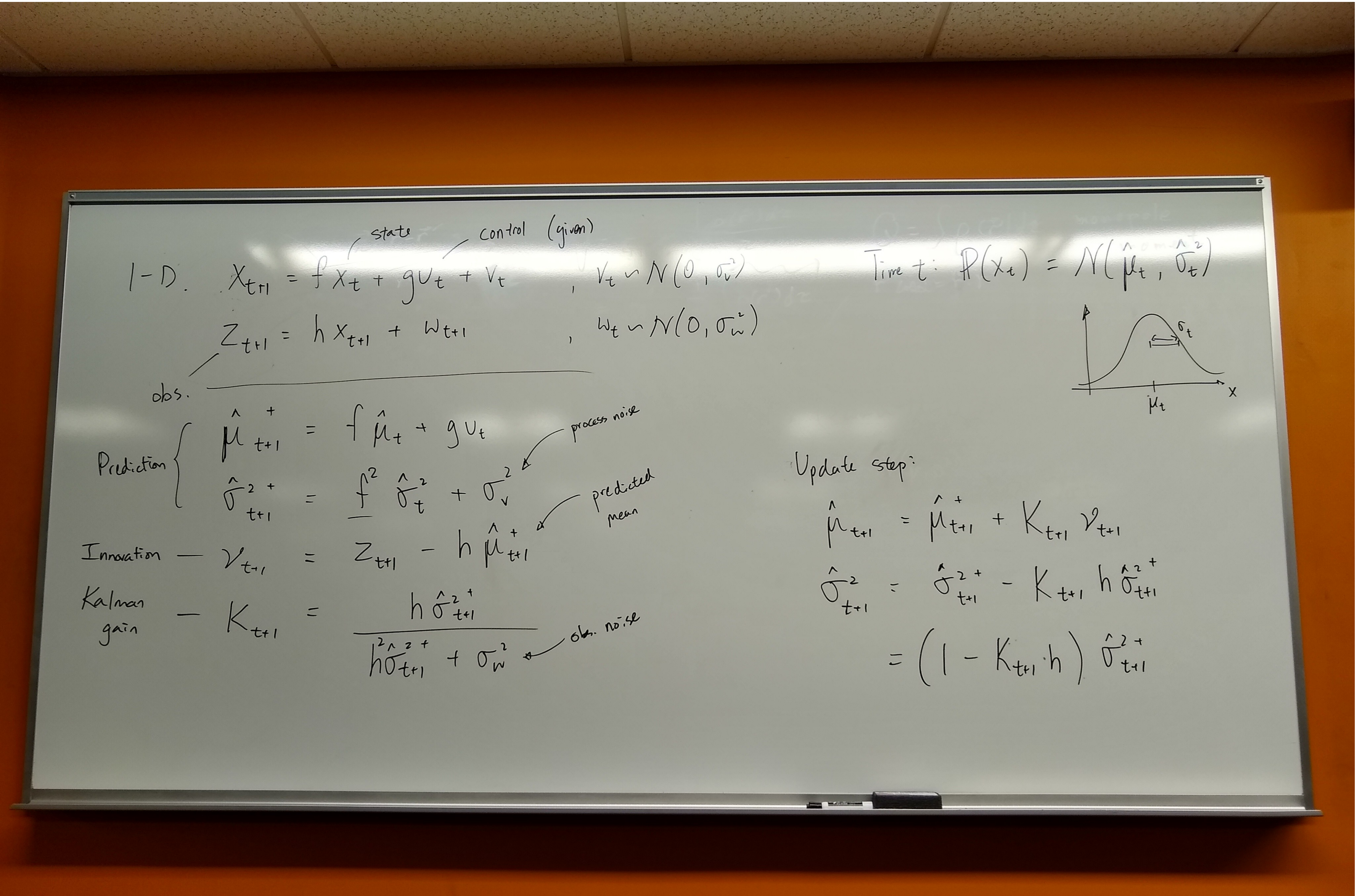
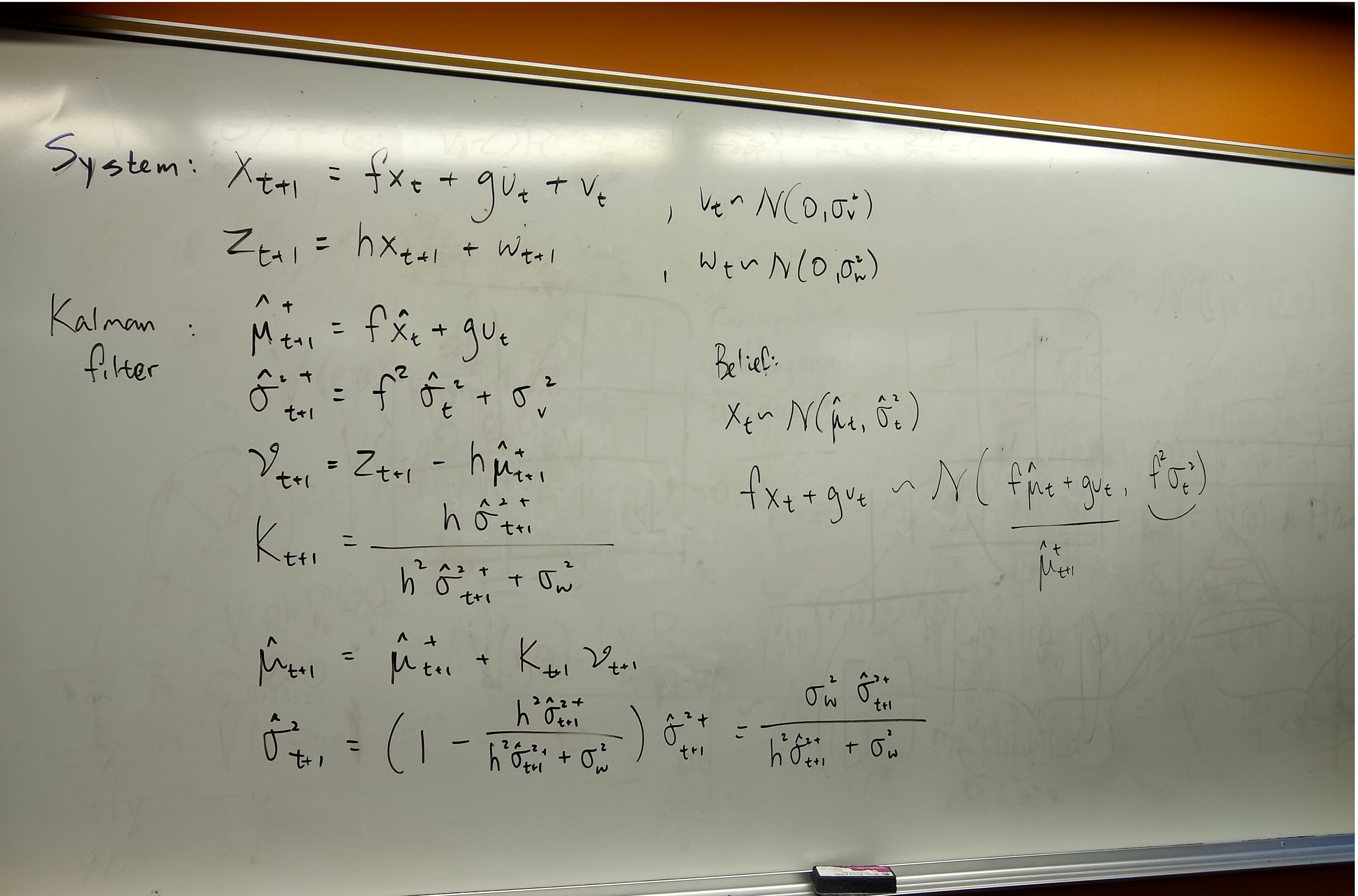
On the board: 1-D Kalman Filter (general)



On the board: 1-D Kalman Filter (general)



On the board: 1-D Kalman Filter (general)



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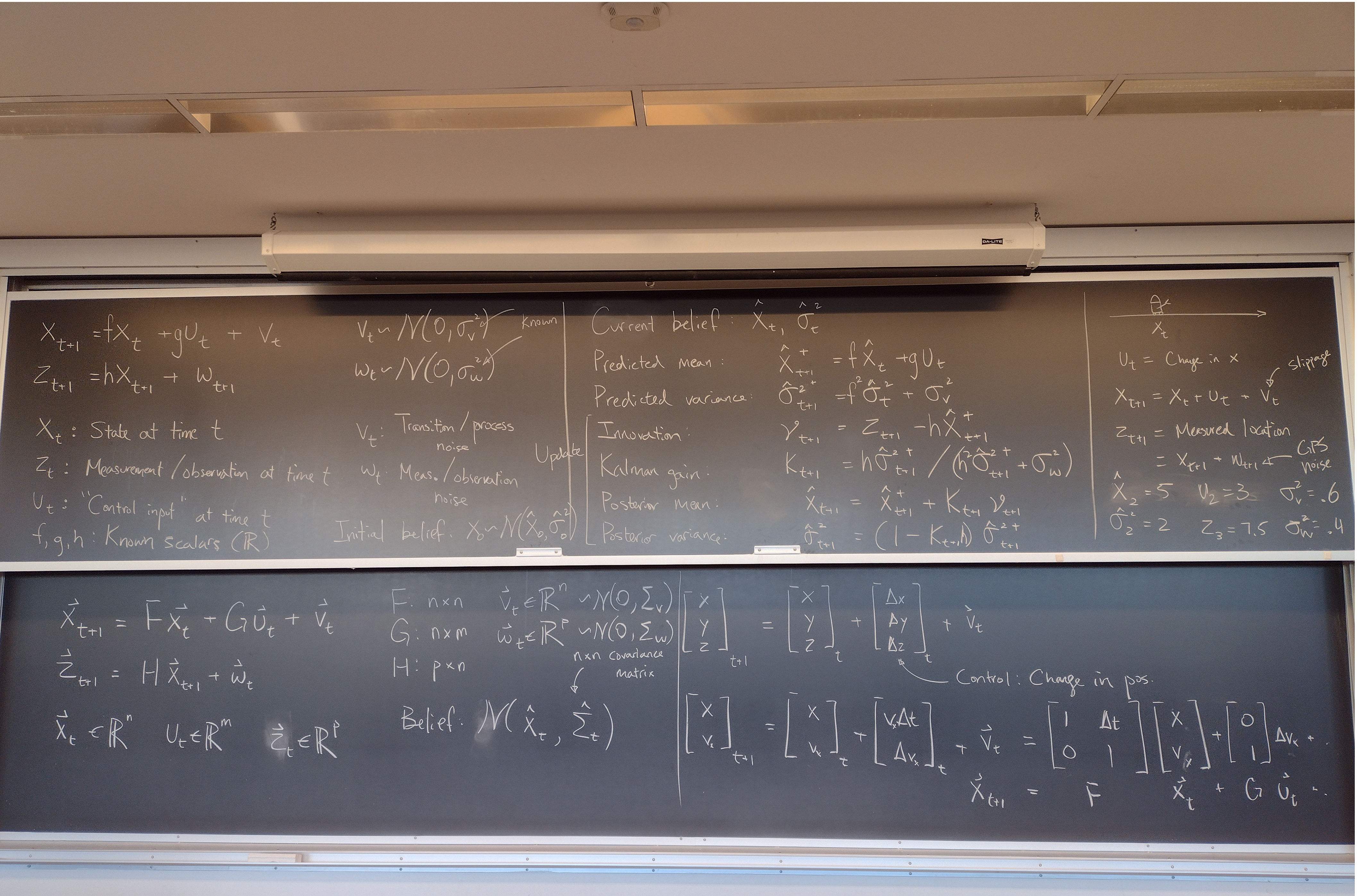
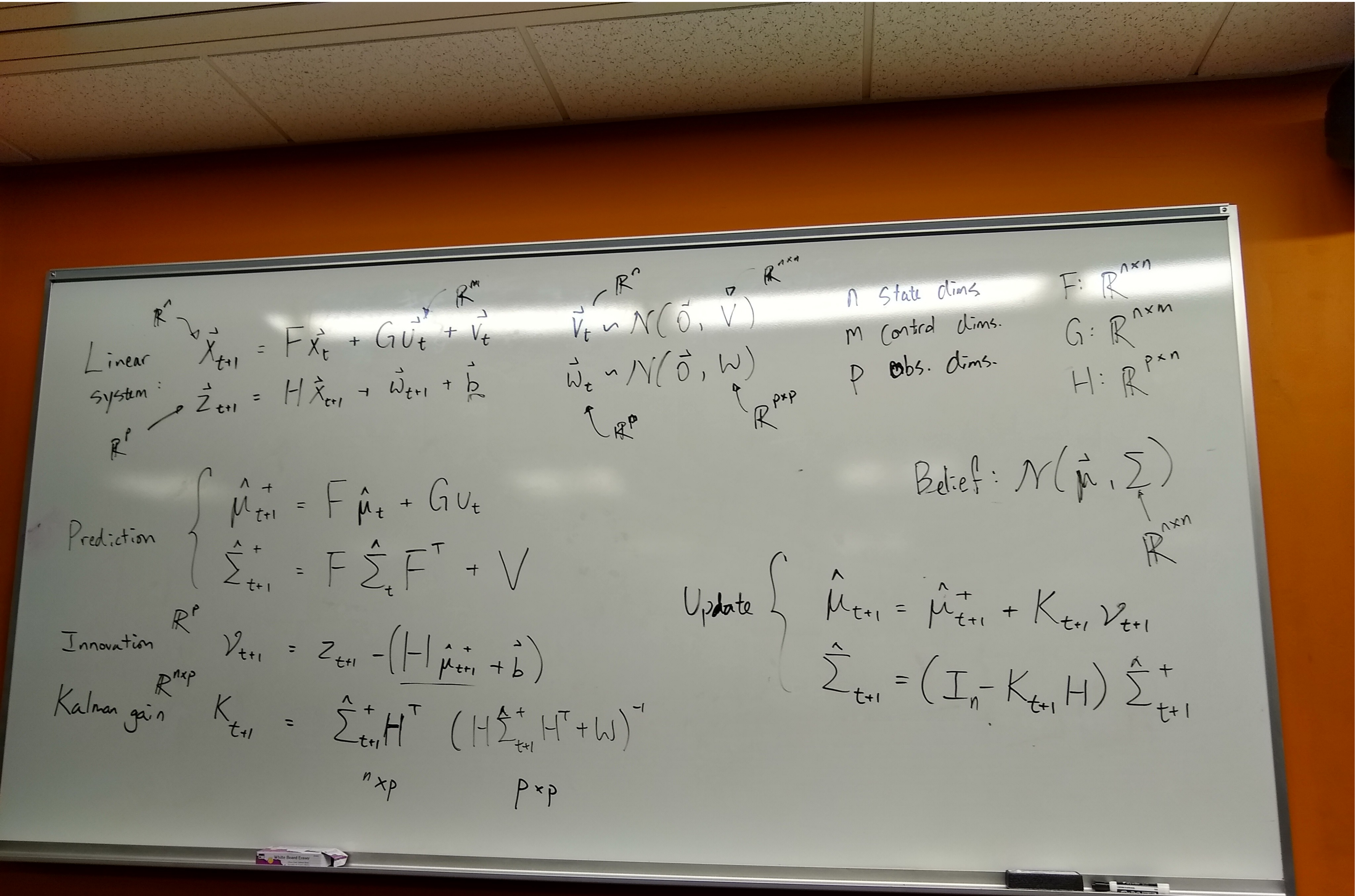
- ✔ Kalman filter (1-D, simplified) + example
- ✔ Derivation of 1-D Kalman filter
- ✔ Kalman filter (1-D, general) + example

Kalman filter (n-D) + example (time-permitting)

On the board (bottom): n-D Kalman Filter



On the board: n-D Kalman Filter



Feedback

Piazza thread: 2/23 Lec 10 Feedback

Please post your answers to the following anonymously.

1. What did you like so far?

2. What was unclear?

3. Did you have a good long weekend?

4. Any additional feedback / comments?

On the board: Bayesian filtering