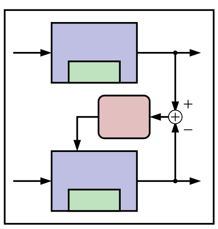
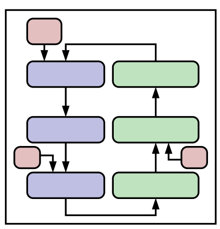
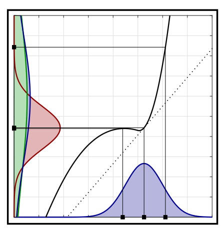
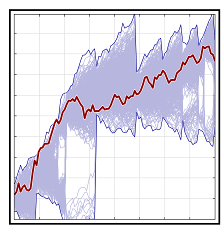
Welcome to the course!

- Welcome to ***Kalman-Filter Boot Camp!***
- Kalman filters (KFs) are algorithms (sequences of calculations) usually implemented as computer programs that use mathematical models and sensor measurements to infer the internal hidden state of a dynamic system.
- Some example applications:
  - In an autonomous vehicle, using video capture and radar measurements to predict the motion of other vehicles and pedestrians (tracking);
  - Using measurements of voltage, current, and temperature to determine "state of charge" and "state of health" of an EV battery (state and parameter estimation);
  - Using GPS and measurements of acceleration to determine my own position, orientation, and velocity in three dimensions (navigation/mapping);
  - And many others!

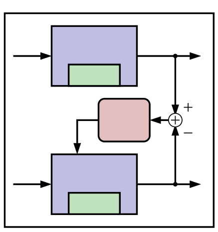
The place of this course within the specialization

- This course is the first in a specialization that investigates the design and application of different kinds of Kalman filters.
- It presents intensive and rigorous training that focuses on developing the "mental muscle" (math skills) needed to proceed to design and implement KFs.
- The subsequent courses in the specialization go into detail to develop the steps you must take to design and implement linear KFs, nonlinear KFs, and particle filters.



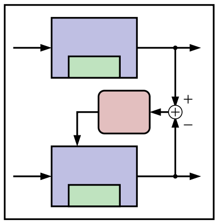
What topics will we study in this course?



In this course, you will learn:

- What a KF does and why you might want to use one for your particular application.
- The kind of mathematical descriptions (models) of dynamic systems that are used by KFs, and how to formulate and simulate these models.
- The way that we will describe uncertain inputs to dynamic systems (noises) and how to simulate models having random inputs (via Octave examples).
- How to interpret the output of KFs, via an example Octave implementation of a state estimator.
- What might cause a KF to fail, unless we take additional measures to deal with these causes.

What skills will you gain in this course?



After completing the course, you'll be able to:

- List elements needed for the design of a KF and applications for which KF might be a good solution.
- Describe features of the state-space type of model that is used by KFs and simulate these models using Octave code for the scenario where the system inputs are deterministic.
- Understand how to describe random inputs to dynamic systems and simulate models of dynamic systems having random inputs using Octave code.
- Implement a KF in Octave code for a state-estimation problem and evaluate its output to determine the KF's estimate and confidence of a model state at any point in time.

Prerequisites; for further study

Prerequisites:

- A B.S. degree in Electrical, Computer, or Mechanical Engr., or
- A B.S. degree with undergraduate-level competency in the following areas:
  - ***Math***: Differential and integral calculus, systems of linear equations, mechanics of linear-algebra (vector and matrix operations), basic differential equations.
  - ***Probability***: Random variables (incl. pdfs, cdfs, expectations), Gaussian RVs.
  - ***Programming***: MATLAB, Octave, or similar scientific program environment.

Optional resource:

- There is no required textbook for this course, but there are some good texts on KF.
- One that I like and use in my UCCS graduate course "Applied Kalman Filtering" is:
  - Dan Simon, *Optimal State Estimation: Kalman, H_∞, and Nonlinear Approaches*, Wiley Interscience, Hoboken, New Jersey, 2006.