Pre-class: Air traffic control model

Hidden states:

[pa_x, pa_y] - actual position (ground truth)

[v_x, v_y] - actual velocity (ground truth)

Observed states:

a - acceleration

[po_x, po_y] - observed position

Calculation:

transition matrix T

emission matrix E

h(t) represent the hidden state at time t, which [pa_x, pa_y, v_x, v_y]

o(t) represent the observed state at time t, which [po_x, po_y]

h(t) = T * h(t-1) - hidden

o(t) = E * o(t-1) - observed

Activity 1:

Kalman filter is used when the intended state cannot be directly measured. We use the input state to create a mathematical representation of the system we want to model and calibrate the mathematical model using states of the output variables that we can observe. With a calibrated model, we can calculate the state of the unobserved output variable with high confidence and accuracy. The difference between the hidden Markov model and the Kalman filter is that the Kalman filter models a continuous variable, where the hidden Markov model, the variable is discrete. Compare to other methods of measurement, Kalman filter converges much quicker to the true value. When using the Kalman filter, we need to calculate the Kalman gain and use it to update the estimate of the variable.

Activity 2:

In this activity, we look at the specific implementation of the airplane position model. The Measurement we have is the position which we can use to calculate the acceleration, and because the radar has a low accuracy, and we can use the predict and update function of "filterpy.kalman" to quickly obtain and converge the actual position of the aircraft. We construct the inferred measurement x and the hidden state covariate matrix p from other parameters using Kalman filter. The resulting plot shows the inferred result has a much better result in therm of fewer noize and follows the ground truth better.

Reflection Poll:
Briefly summarize the process of solving a novel problem with a Kalman filter. Make specific references to points raised in both discussions.

Solving a novel problem requires us to find out the observed state and hidden state of the system, where the hidden state is the state we are interested in optimizing toward the ground truth. The next step requires us the define the transition matrix between the states and run the simulation. Kalman filter will optimize using the available observed states to make a better estimate of the hidden state.