Kalman Filter Cheatsheet

Kalman Filters Maths

PREDICT IN KALMAN FILTER BOOKS

$$x' = Fx + u$$
$$P' = FPF^T + Q$$

UPDATE IN KALMAN FILTER BOOKS

$$y = z - Hx'$$
$$S = HP'H^T + R$$
$$K = P'H^TS^{-1}$$

$$x = x' + Ky$$
$$P = (I - KH)P'$$

How to set up your matrices in any linear Kalman Filter

Variables

Let's consider

- A **vector x** representing the state
- A **vector z** representing the **measurement.**

X will represent our state

- If we track a robot in 1 dimension, the state will be: x = **[x, x dot]**^{T}.
- If we track a robot in 2 dimensions, the state will be: **[x, y, xdot, ydot]**^{T}.

—> dim_x will represent the dimension of x (2 in 1D, 4 in 2D, 6 in 3D, …).

Z will represent the measurement

- If we measure a robot in 1 dimension, the vector will be z = [x].
- If we measure a robot in 2 dimensions, the vector will be z = [x, y]^T.

—> dim_z will represent the dimension of z (1 in 1D, 2 in 2D, 3 in 3D, …).

Dimensions of matrices

Predict

- X = [dim_x, 1] - State
- P = [dim_x, dim_x] - Uncertainty
- Q = [dim_x, dim_x] - Process noise
- F = [dim_x, dim_x] - Transition Matrix

Update

- H = [dim_z, dim_x] - Measurement function
- R = [dim_z, dim_z] - Measurement noise
- z = [dim_z, 1] - Measurement vector
- K = [dim_x, dim_z] - Kalman Gain
- y = [dim_z, 1] - Error
- S = [dim_z, dim_z] - System error
- SI = [dim_z, dim_z] - Inverse of S
- I = [dim_x, dim_x] - Identity Matrix