KALMAN FILTER Implementation

BLUE = inputs,
RED = Outputs,
BLACK = constants,
Gray = Intermediate variables

State prediction (predict where we're going)	$x_{predicted} = A x_{n-1} + B u_n$
Covariance prediction (Predict how much error)	$P_{predicted} = A P_{n-1} A^T + Q$
Innovation (compare reality against prediction)	$\tilde{y} = Z_n - H x_{predicted}$
Innovation co-variance (compare real error against prediction)	$S = H P_{predicted} H^T + R$
Kalman Gain (moderate the prediction)	$K = P_{predicted} H^T S^{-1}$
State update (New estimate of where we are)	$x_n = x_{predicted} + K \tilde{y}$
Covariance Update: (New estimate of error)	$P_n = (I - KH) P_{predicted}$

→ Next Output prediction
→ Next Error prediction
— Prediction.

→ Differ b/w reality & prediction
→ Differ b/w real error & predicted error
— change in o/p & error

→ Kalman Gain calculation
→ update Estimate
→ Updated Error
— update

Inputs:

U_n = Control Vector, This indicates the magnitude of any control system's or user's control on the situation

Z_n = Measurement vector. This contains the real world measurement we received in this time step.

Outputs:

X_n = Newest estimate of current "true" state

P_n = Newest estimate of the average error for each part of the state

Constants:

~~As state~~

A = State transition matrix. Basically, multiple states by this and add control factors, and you get a prediction of the state for the next time step.

B = control matrix. This is used to define linear equations for any control factors.

H = observation matrix. Multiply a state vector by H to translate it to a measurement vector.

Q = Estimated process error covariance. Finding precise values for Q and R are beyond the scope of this guide

R = Estimated measurement error covariance.

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example

$V_n = V_{n-1} + w_n$.

process random noise.

1. $V_n = V_{n-1} \rightarrow A = [1] = [1]$

A = 1.

Since it " is for strong measurement to convert into state. H = 1

B = control matrix, since voltage is not controlled, B = 0.

Q = covariance, since we know exact covariance we use little.

= 0.00001

matrix R = the measurement covariance R = 0.1

Xnext = Initial prediction of vol

Xnext = 3

Pnext = initial prediction of covariance, since we don't know we use P = 1.