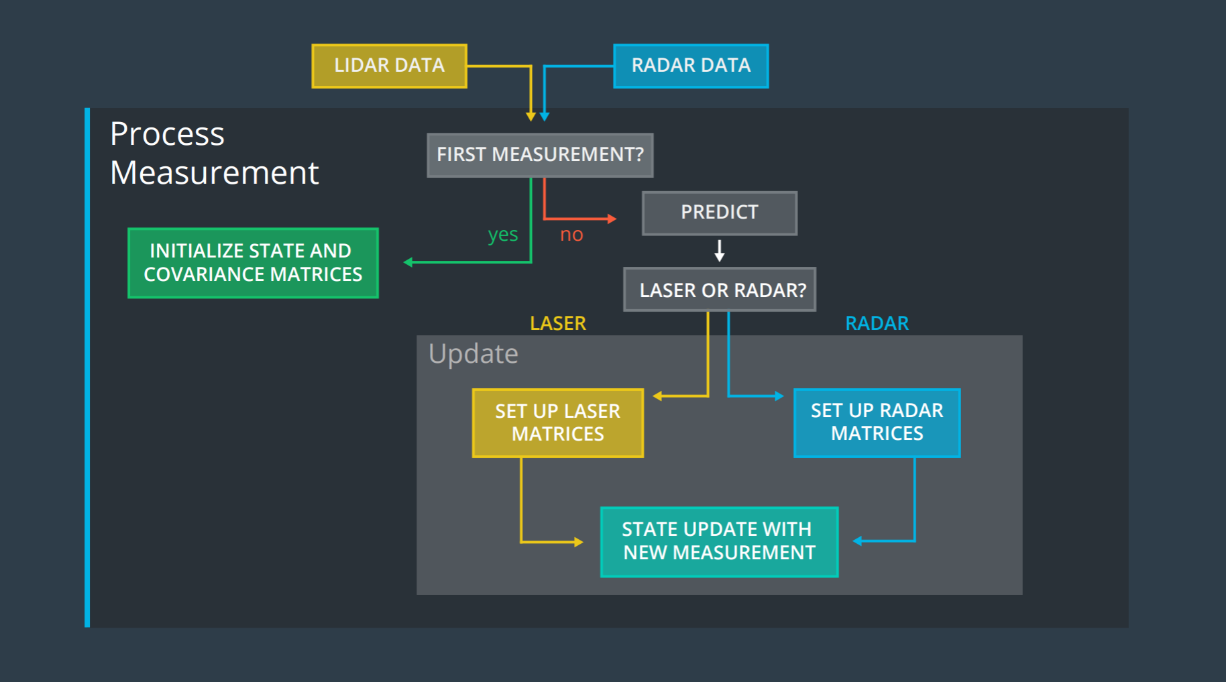
Kalman Filters don’t need to only be used with sequential measurements from one sensor. It can be used to combine measurements from different sensors.

We can use LIDAR and RADAR sensors together to overcome each of their individual weaknesses to estimate things like pedestrian location, heading, and speed.

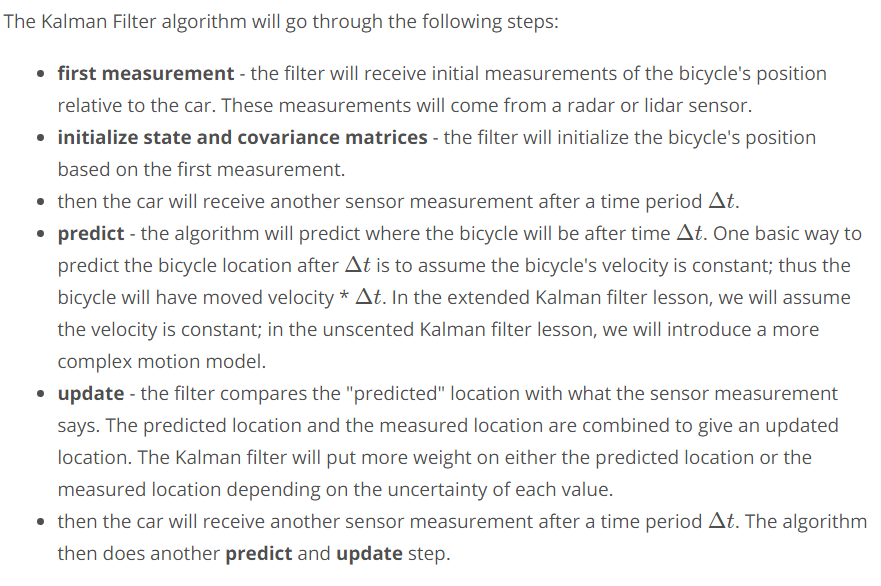
**Kalman Filter Based Sensor Fusion**

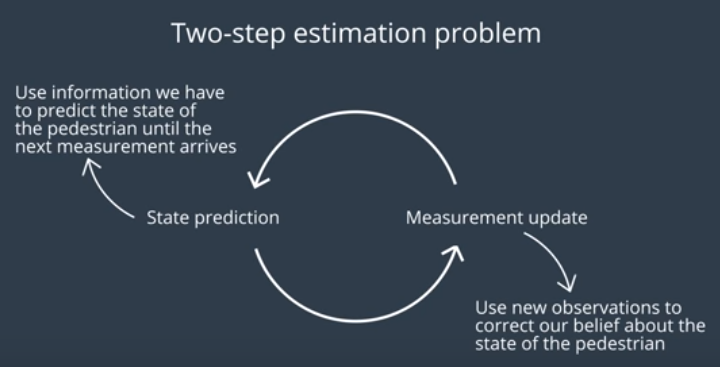


**Extended Kalman Filter**: A Kalman Filter with the capability of handling more complex motion and measurement models.

Process:

1. Sensor Info is used to estimate the state of an object in motion. The state is represented by a 2D position and a 2D velocity.
2. With each new measurement from the sensor, the estimation function is triggered to perform 2 steps of State Prediction and the Measurement Update
3. Prediction step provides a prediction of the state and its covariance. This is done by taking a lapse time between the current and previous observations.
4. Measurement Update step depends on sensor type. If the current measurement is Laser Data, a standard Kalman filter measurement step can be done. However if it is RADAR data involves a nonlinear measurement function. To handle non-linearity’s, we use different tweaks to handle the measurement step like extended **Kalman Filter Equations**.





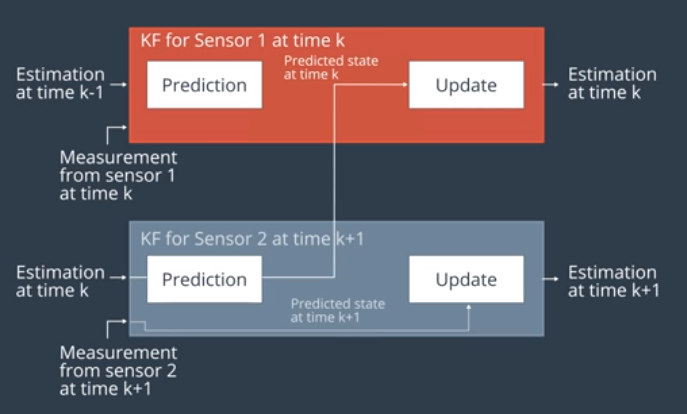
Always starts with initial state prediction, and is an endless loop of prediction and measurement steps.

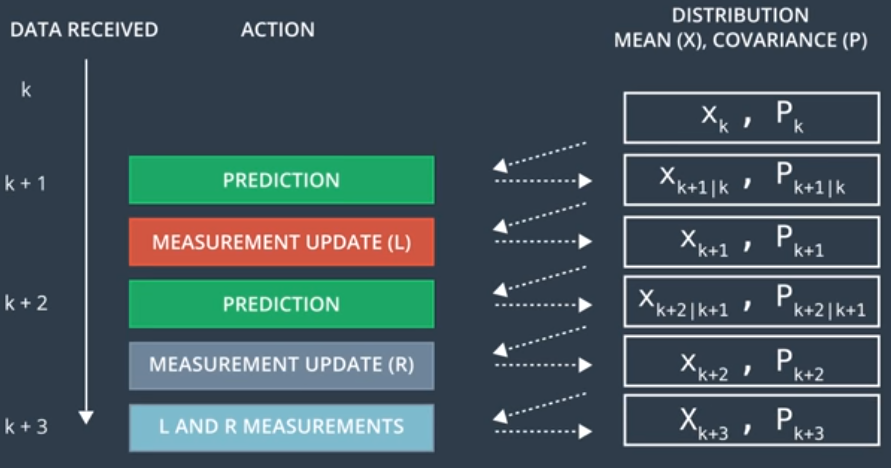
**What Happens when there are 2 sensors measuring the same pedestrian?**

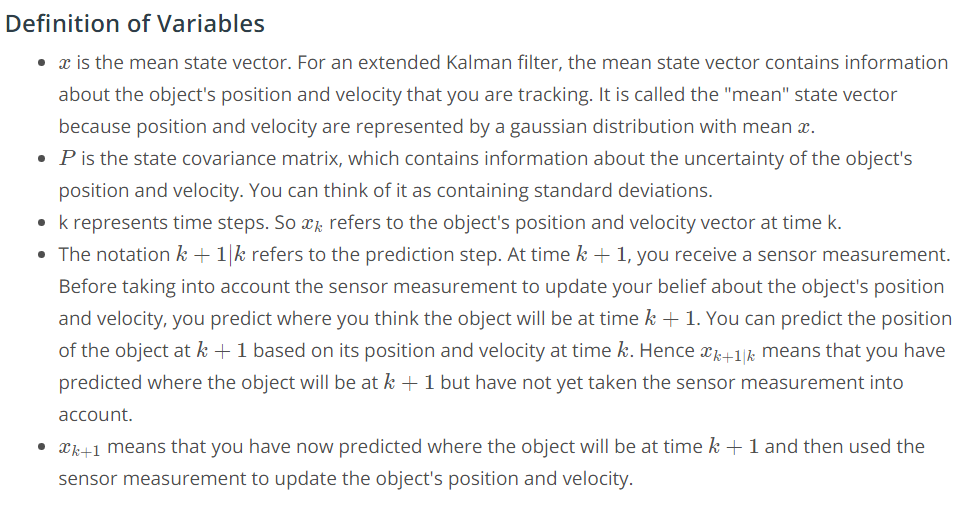
One way to handle both sensors is to keep the same process but to have each sensor have its own predict and measurement scheme.

This means the belief about the pedestrian’s position and velocity is updated asynchronously each time the measurement is received regardless of the source sensor.

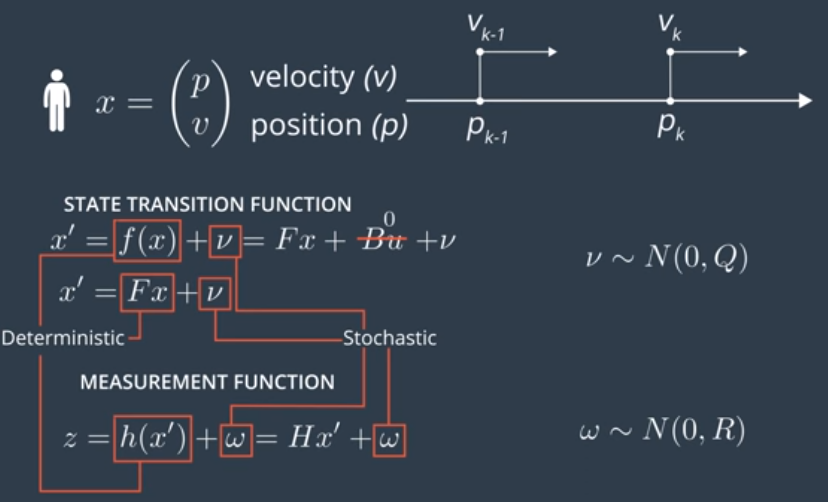
Although the state prediction method is the same for both sensors, the measurement update is different for LIDAR and RADAR. LIDAR measurements are in Cartesian co-ordinates and RADAR measurements are in Polar Co-ordinates.

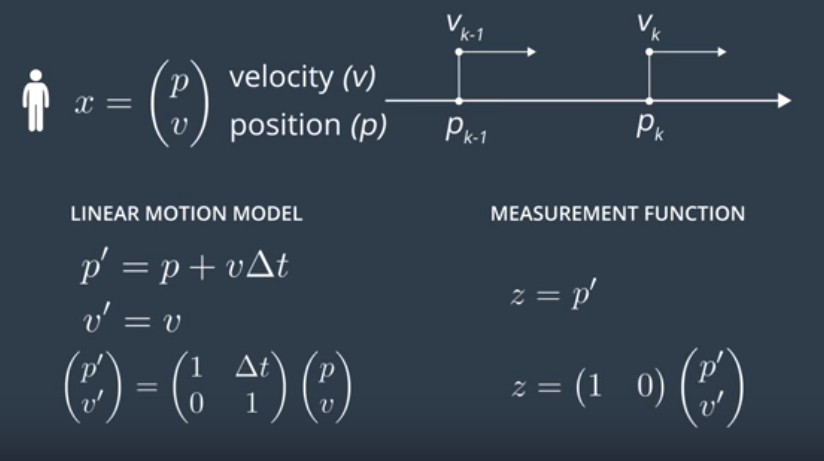


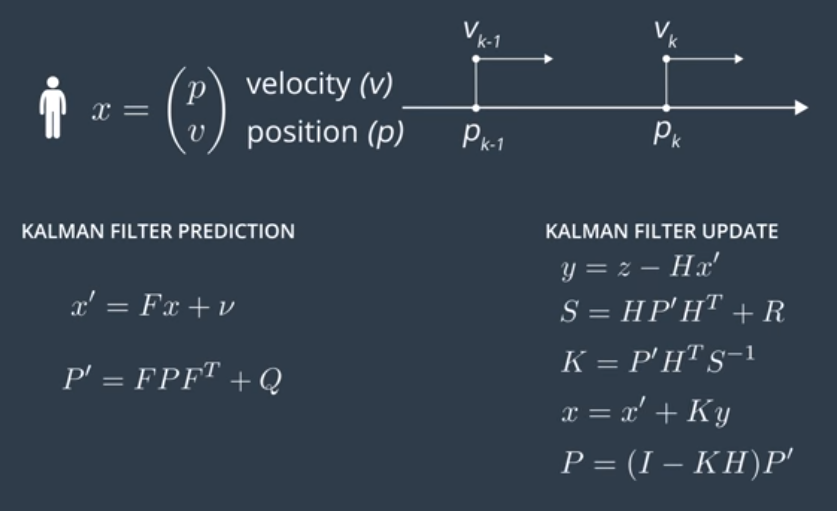


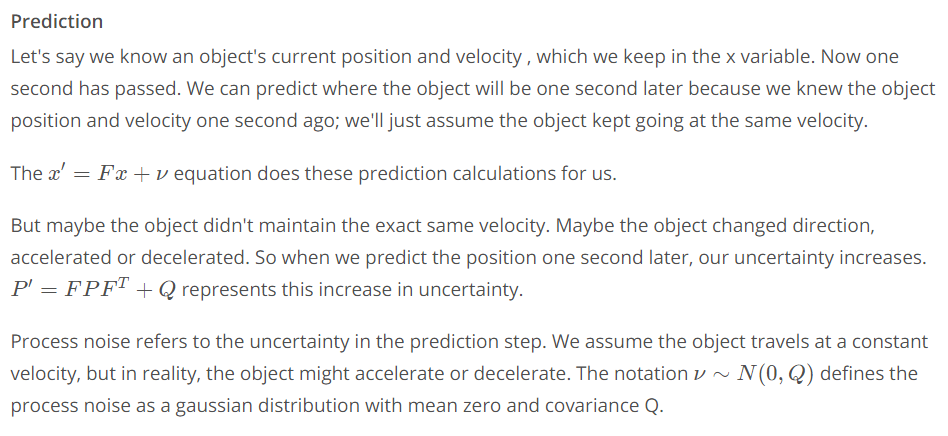


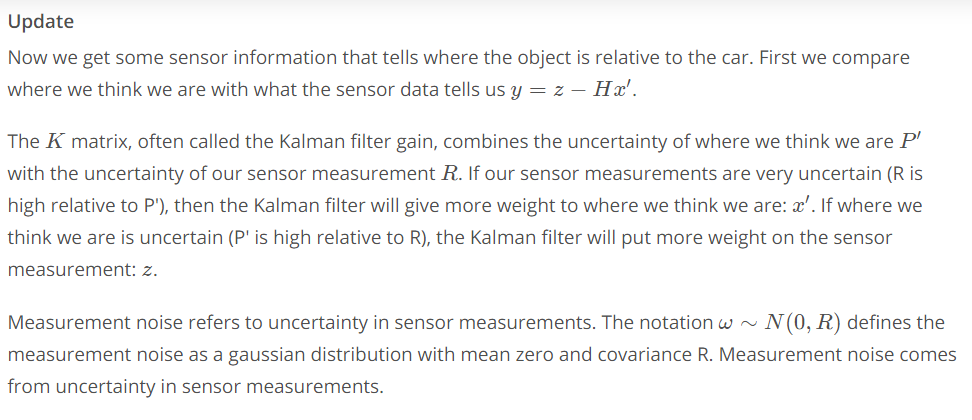
If both LIDAR and RADAR data come at the same time (K + 3), we should Predict the state to k+3 then use either one of the sensor to update. Afterwards we should predict the state K+3 again and update with the other sensors measurement. (Since both predictions for K+3 are the same, it can be a Prediction, Update, Update).

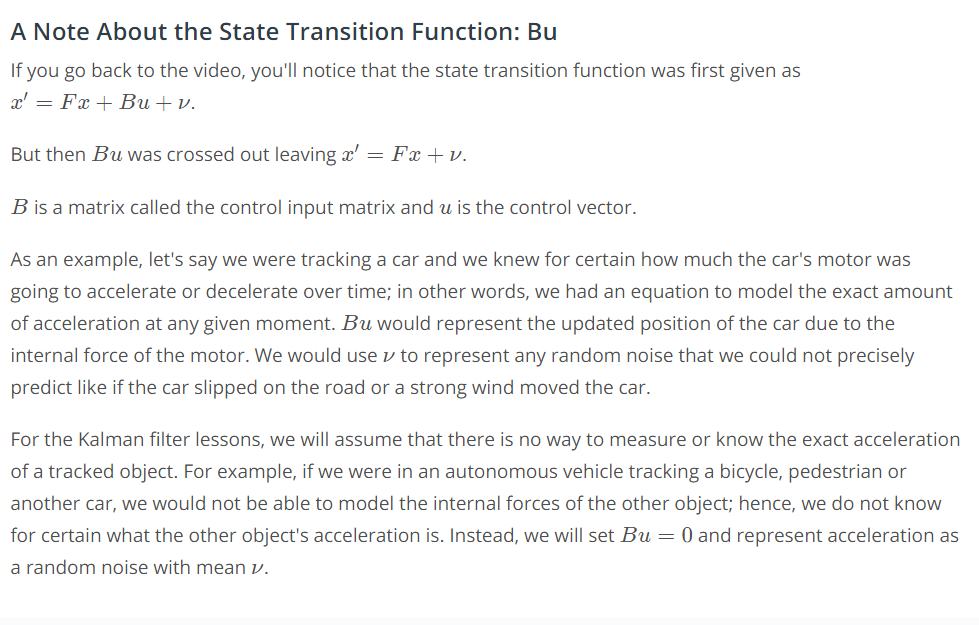












Process Noise, u, can be set to 0 because of it is random process that has a mean of 0. The process noises covariance is added to the Covariance prediction.