Kalman Filter Part III: UKF

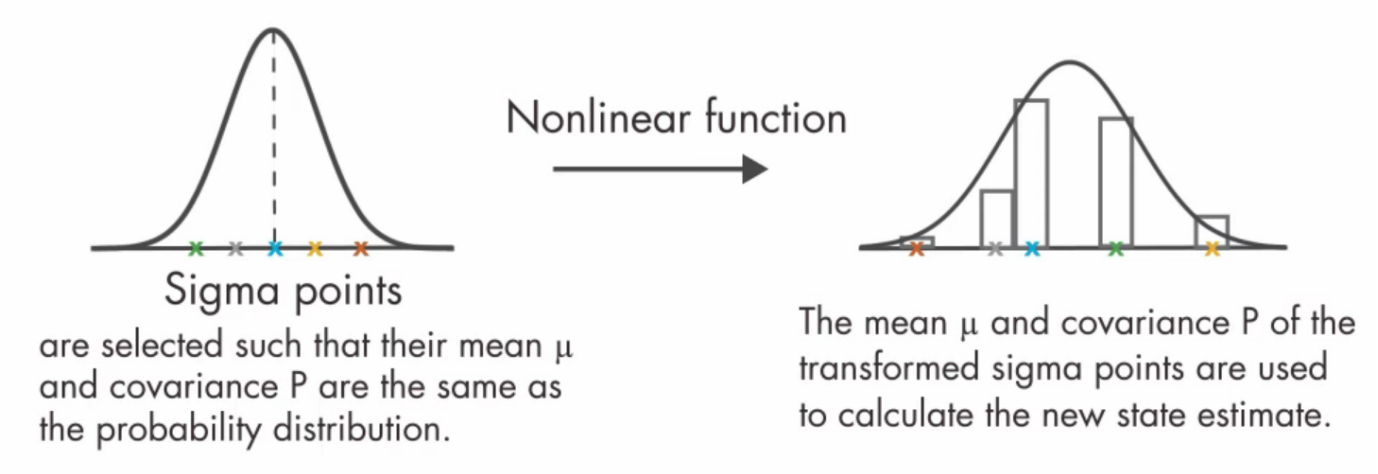
Why UKF ?

In Kalman Filter Part II: EKF, we try to linearly approximate the non-linear relationship. However, if the non-linearity is too complex, the computation cost of Jacobians will be too big.

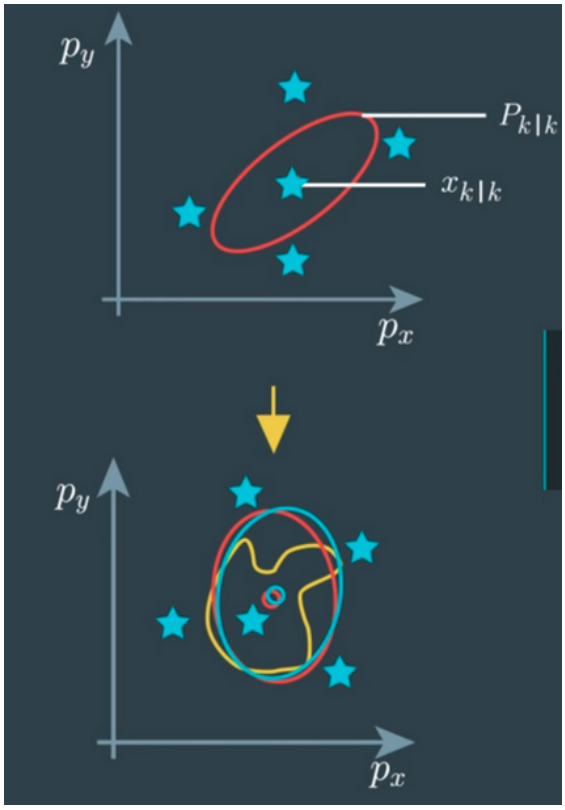
UKF is also applied to non-linear relationship and with better solution.

What is UKF ?

The figure below is a brief illustration about how UKF works:



As shown in the figure, UKF still remains the non-linear relationship, however, it's only applied to some **sigma points.** The figure below is also a good illustration about how UKF works:



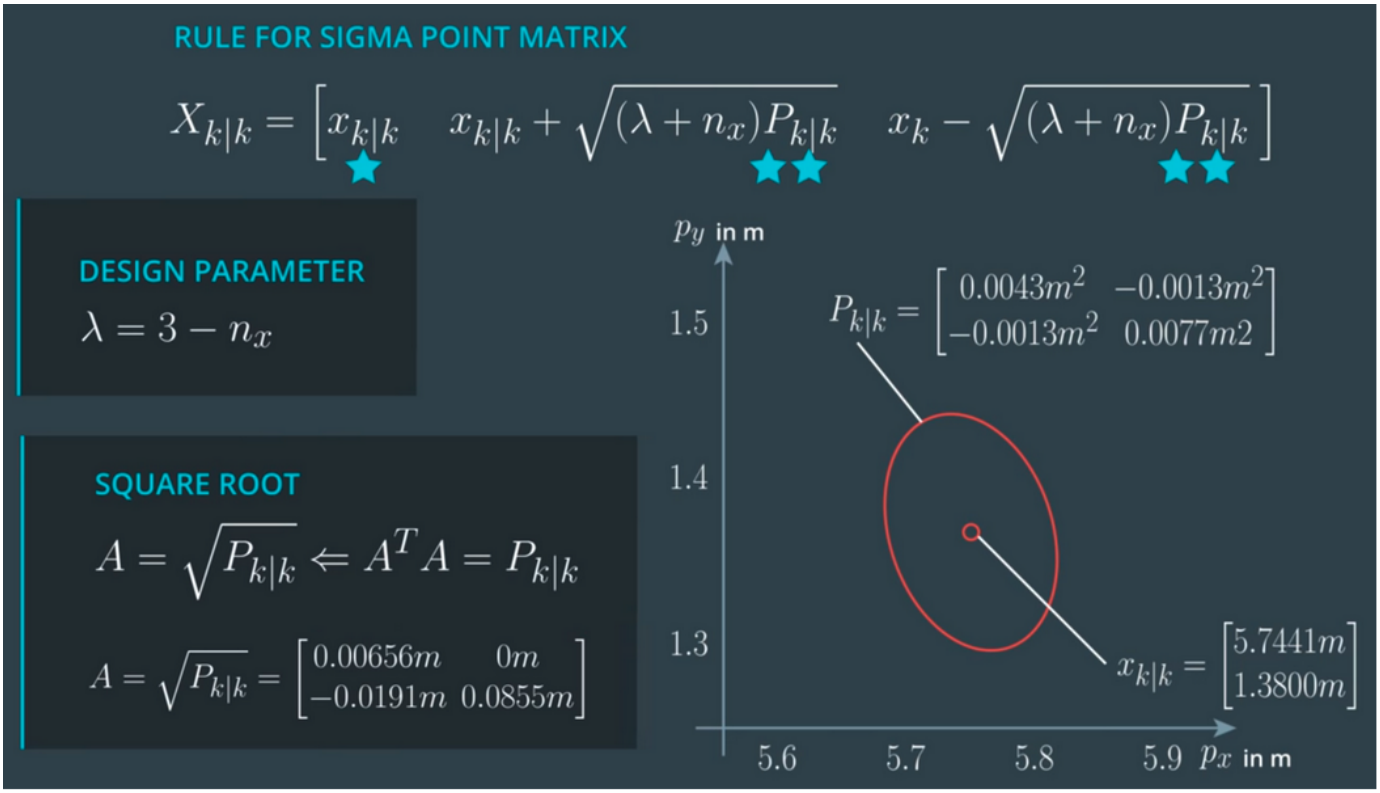
The original Gaussian distribution is the **red ellipse** in the upper part. After non-linear transformed, it becomes the **yellow line** in the lower part. However, the actual Gaussian distribution is supposed to be the **red ellipse** in the lower part.

What UKF does it to transform the **5 blue stars (sigma point)** in the upper part and use the **transformed stars** in the lower part to approximate the Gaussian distribution (the **blue ellipse**)

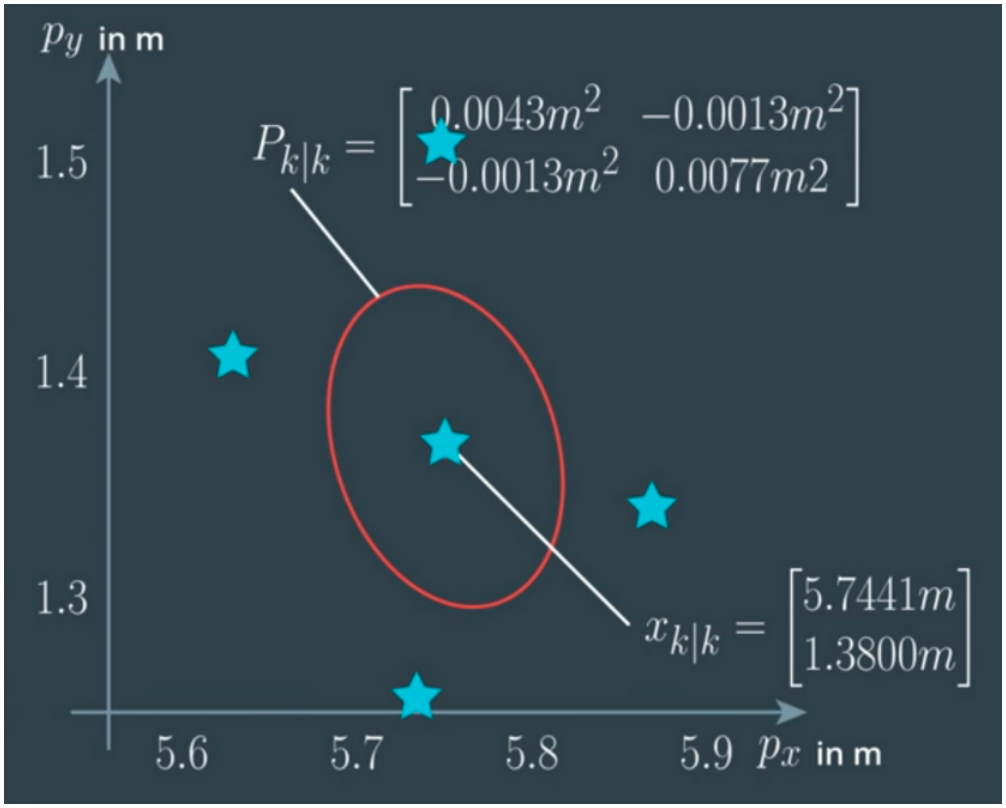
How to choose sigma points ?

Assume state dimension is ***n***, then we choose ***2n+1*** sigma points. Lets' take ***n = 2*** as an example.

We will have 5 sigma points when ***n = 2***. The first point is the **mean vector**. Then we perturb on both positive and negative direction on each dimension, means how far away the perturbation you want.



Be careful, the dimension here is after **whitening** (in case the original Gaussian distribution prefers one of the dimensions). Below is the sigma points of our example



UKF with CTRV Motion Model

https://bobondemon.github.io/2017/04/12/Unscented-Kalman-Filter-Notes/