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Lecture by Hao Peng

The presentor uses trained machine learning coupled with Baysian filters to improve orbital prediction accuracy of RSO's (resident space objects such as satellites). I was impressed that application of the ML model changed the RSO's flowfield to a large extent.

The ML correction is applied at Step (3) in the fig(1) (right, this page) of two Baysian filters to reduce stoachistic measurement from the RSO's sensors (gyroscope, accelerometers), that track its position, and the error of each measurement, the two-line element set (TLE) e_z, e_{vz}, the errors in its interial plane position and velocity. TLEs can be easily updated and propagated to make accurate predictions of the position of objects in space.

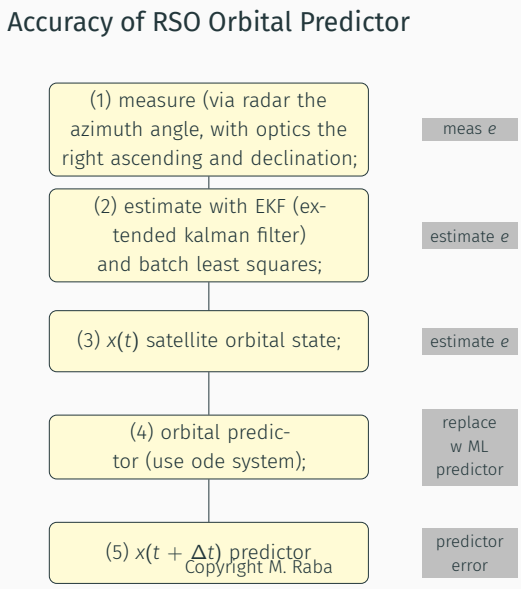
These two filter algorithms are particle filter and EKF. They estimate the state of the dynamic system $x(t + \Delta t)$ from new data (as it becomes available. The first excels at gaussian noise, and the second is apt for nonlinear noise of the measurement data. The data is publically available ENVISAT (EU open source data from a satellite operating during 2002-2012).

This change of path represents a reduction in the model error. All models are approximations and therefore will have systematic error, for example, because a factor is not included in its model, and the total error is

$$e = h_{ml} + v_{ml} \tag{1}$$

The data sets can be combined using ML to improve the model to reduce the along-track error of the RSO. Given the ML improvement, and the convergence of the improved scheme (shown above in fig (1)) one would expect the prediction accuracy to be greatly improved, however, more validation must be done using further TLE data (for example, the data set may be insufficiently dense) and could lead to prediction errors.

Last, the presentor makes a point that



$$\text{convergence in ML} \quad \not\Rightarrow \quad \text{useful for Aerospace Engineers} \tag{2}$$

$$\text{good enough solution for AE} \quad \not\Rightarrow \quad \text{ML solution may not converge} \tag{3}$$

As a final word, the presentor suggests that ML is a proposal generator for funding.