# DATA FUSION III, Estimation Theory

**Date:** February 23 – March 23 (5 Thursdays) **Time:** 5:00 – 7:30 PM
**Instructor:** Dr. James K Beard
**Credits:** 1 **Course Code:** 0901-501-05 **Registration Number:** 13460

Estimation is the principal enabling technology applied to tracking and data fusion. Simple examples are used to illustrate basic methods and show how probability and statistics underlie simple algebraic descriptions of well-known estimation techniques, which we use as a basis for showing the estimation theory basis of the Kalman filter.

The method of maximum likelihood is a basic approach for designing estimators that use the Maximum Likelihood Estimators (MLEs), which are known to provide estimates which have the smallest mean square errors that can be provided from a given set of data. The classical basis for maximum likelihood is presented and extended to the vector case, such as estimating aircraft position in two or three dimensions from radar data. We show how the Kalman filter is related to MLEs.

The classical estimation methods of maximum likelihood, maximum *a priori* (MAP), and Bayesian estimates are presented and compared. We discuss the practical issues with application and use of these estimators, such as biased estimates and how to remove biases.

A major problem in data fusion is gridlocking, or dealing with slight alignment differences in separate platforms such as a tiny difference in true North. Another is the use of track file data, which is filtered radar contact data rather than raw data. We present a way that these problems are solved in practical systems.

**Who should attend:** The primary audience is the engineer who needs to understand the requirements, interpretation and use of trackers and the use of tracker data in facilities that use data from multiple radars such as air traffic control consoles. The engineer who plans to be involved with projects that include integration data from radar trackers, or who will be involved in writing or interpreting data fusion requirements, or in development, design, and maintenance of systems that perform data fusion.

**Prerequisites:** Probability and Statistics is very important; we will refresh and extend this material but will rely on significant background. Another requirement is a basic understanding of elementary vectors and matrices, to include matrix multiplication of vectors, and determinants and inverses of matrices. The student should be capable of using Matlab or another general purpose software environment for simple problems.