Indian Institute of Tropical Meteorology
Pune, India

A Short Course on
Dynamic Data Assimilation: Theory and Applications
June 26- July7, 2017

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Scope: Each of us one time or other have looked into the crystal ball to check how the future looks. Many aspects of human life are controlled by prediction/forecast of one kind or another. Forecast is often riddled with errors. In this course we provide a classification of forecast errors and develop methods for correcting forecast errors using Dynamic Data Assimilation - which is a process for systematic fusion/merging of data into the models. There is a close connection between Inverse Problems and Data Assimilation. Our aim is to provide a broad background on the basic principles and mathematical tools needed to assimilate data into models of various kinds and analyze the forecast generated from the assimilated models.

Topics to be covered:

(i) Data Mining, Data Assimilation and Prediction - parts of a continuum, (ii) An overview of mathematical tools - linear vector spaces, matrices, multivariate calculus, principles of optimization, (iii) Formulation of inverse problems - static, deterministic models: linear and nonlinear least squares, (iv) Solution of inverse problems: matrix methods - Cholesky, QR- decomposition, SVD, iterative methods, (v) Solution of inverse problems: optimization methods - gradient, conjugate gradient, quasi-Newton methods, (vi) Optimal interpolation, successive corrections, nudging methods, (vii) Assimilation of data in dynamic, deterministic models - first-order adjoint/4-DVAR method, forward sensitivity method (FSM), (viii) Assimilation of data in linear stochastic dynamic models - Kalman Filtering, (ix) Assimilation of data in nonlinear stochastic dynamic models - first-order/extended Kalman filter, second-order filter, unsented filter and (x) Assimilation of data in nonlinear stochastic models - principles of ensemble/reduced rank filters.

Note: A good working knowledge of programming in MATLAB would greatly facilitate the practical sessions

Potential audience:

This course would be of interest to a large segment of graduate students, researchers/scholars working in the broad areas of "Data Mining, Data Assimilation and Predictive Sciences".

Modus Operandi:

1) On each working day (Monday, June 26th through Friday, July 7th, 2017) we will have two sessions - first in the morning (9.00 am to 1.00pm) and the second (2.00 to 5.00pm) in the afternoon.

2) The morning session will include two lectures between 9.00 am and 1.00 pm with ample room for coffee break and discussions. The afternoon session will consist of one lecture followed by a Practicum session between 2.00 to 5.00pm with ample time for coffee break and discussions. Each lecture and the practicum session will be for 75 minutes.

References

[1] J.M. Lewis, S. Lakshmivarahan and S. K. Dhall (2006) *Dynamic Data Assimilation: a least squares approach,* Cambridge University Press

[2] S. Lakshmivarahan, J.M. Lewis and R. Jabrzemski (2016) *Forecast Error Correction using Dynamic* Data *Assimilation*, Springer

[3] S. Lakshmivarahan (2016) NPTEL on-line lectures on "Dynamic Data Assimilation", hosted by IIT-Madras

A short Bio of Prof. S. Lakshmivarahan: After completing his PhD from the Indian Institute of Science, Bangalore, India in 1973, S. Lakshmivarahan served as an assistant professor at the Indian Institute of Technology, Madras, India (1973-75), a visiting assistant professor at the Division of Applied Mathematics , Brown University (1975-76) and Electrical Engineering at Yale University (1976-78) before joining the School of Computer Science, University of Oklahoma, Norman, Oklahoma in 1978 where he is a George Lynn Cross Research Professor since 1995. He is the Fellow of the IEEE (1993), ACM (1995) and IEEE Life Fellow since 2013. His interests are in Applied Mathematics and Computation.

Interested participants may send their resumes along with recommendation letter from their HOD or head of the institute to Dr. C. Gnanaseelan (seelan@tropmet.res.in), Scientist-F, Indian Institute of Tropical Meteorology, Dr. Homibhabha Road, Pune-411008 by 15 April 2017.