Introduction

The problem of estimating the unobserved states of a system from observed data often arises in many branches of science, ranging from tracking the location of an object from radar-based observations to estimating the volatility from observed prices of financial securities. Filtering refers to any method for obtaining such state estimates, recursively in time, by combining model predictions with noisy observations. If the future state depends linearly on the present state, a state estimator which is optimal in certain sense is known after its inventor as Kalman filter (KF) is popular in engineering, finance and econometrics since 1970s. While the use of KF is well-understood for linear models, nonlinear models are often needed to describe the observed dynamics adequately. Exact nonlinear filtering is often impossible and various Bayesian approximations exist to solve the filtering problem. Over the last two decades, significant advances have been made in theory and applications of nonlinear filtering.

The proposed course will guide the participants through the theory and practice of linear and nonlinear filtering. Theory, including the state of the art developments in filtering as applied in different branches of engineering will be taught through class-room based lectures. The participants will have an opportunity to implement the filtering algorithms they learn in the class on prototype simulations in a high level programming language such as Matlab, in supervised tutorial session.

Objectives

- Exposing the participants to the state of art knowledge on nonlinear estimation.
- Providing exposure to practical estimation problems in engineering.
- Building confidence in designing filters for real-life problems through hands-on simulation sessions.
- Enhancing capabilities of the participants in identifying estimation problem and implementing suitable estimators to achieve the chosen objectives.

Course instructors

- Shovan Bhaumik is an Associate Professor of Electrical Engineering Department, Indian Institute of Technology Patna. His research interests include nonlinear estimation, statistical signal processing, control systems and their applications in military target tracking.

Course contents

Day 1

Lecture: Linear algebra, matrix operations, QR decomposition, concept of state space approach, random process, stationary, ensemble, ergodicity, multivariate probability density functions.

Tutorial: Solution of state space, generation of random numbers, simulation to estimate truth of a multi dimensional linear system.

Day 2

Lecture: Motivation and basics of filtering, prediction and smoothing, linear Gaussian systems, white noise, filtering problem for linear Gaussian case, KF recursion. KF properties, convergence

Tutorial: Simulation session: estimation of states for a linear systems, understanding and interpretation of results.

Day 3

Lecture: Linearization for nonlinear systems, the extended Kalman filter, imitations. Unscented transformation, generation of support points and weights, unscented Kalman filter, Cubature rule of Integration, Gauss-Laguerre rule of integration, generation of support points and weights, cubature quadrature Kalman filter

Tutorial: Supervised programming session: estimation of states for a multi-dimensional nonlinear filtering problem with EKF, UKF, CQKF.

Day 4

Lecture: Bayesian framework, approximating pdf with particles and weights, iid samples, sequential importance sampling, choice of importance density, resampling, particle filter algorithm, computational issues.

Tutorial : Supervised programming session to assist to write a particle filter code.

Day 5

Case study: Tracking an underwater target using bearing only measurements, shifted Rayleigh filter.

Tutorial: Supervised programming session to assist to write a target motion analysis code using bearing only measurements.

Venue

Classes and programming session will be held in IIT Patna Campus.

Minimum Prerequisite

Basic knowledge of a high level programming language such as Matlab, and basic knowledge of mathematics which is commensurate with the first two years of an undergraduate degree study in engineering or physical sciences.

Registration fee

The Participation fees for attending the workshop are as follows:
Industry: Rs. 25,000
Academia: Rs. 10,000
Student/Research Scholar: Rs. 7,500
The above fee includes all instructional materials, tutorials, Internet and laboratory facilities during class hours.
A Certificate of participation from IIT Patna will be awarded to all participants after successful completion of the course.

Mode of Payment

The participation fees for the CEP programmes will be accepted only through Demand Drafts drawn in favour of "Indian Institute of Technology Patna" or e-transfer/RTGS/NEFT, or e -transfer:

Bank: State Bank of India

Branch: IIT Patna, Bihta

Bank Account No. : 30957551934

Account Type : Savings A/c

IFSC: SBIN0017164, MICR Code : 801002005

Beneficiary: Indian Institute of Technology Patna

How to Apply

Scanned copy of the filled in registration form should be sent to shovan.bhaumik@iitp.ac.in by January 28, 2020. For any query contact course coordinator.

How to Reach

IIT Patna's campus is located at Bihta, 35 km from Patna and 20 km from Ara, at a 501 acres site. The nearest railway station is Bihta, 2 km from the campus. IIT Patna has good road connectivity to and from Patna and Ara. Regular bus services have been provided by the Govt. of Bihar from Gandhi Maidan, Patna to IIT Patna campus. The nearest airport to reach IIT Patna campus is Jai Prakash Narayan Domestic Airport, Patna, which is located 25 km from the campus.

Accommodation

Shared/single accommodation and boarding facilities are available in the Institute Guest house and Students hostels (with nominal cost) for a limited number of participants on payment basis. Private hotels are readily available both in Bihta and Patna.

Registration Form

1. Name: _____
2. Date of Birth (dd/mm/yyyy): _____
3. Sex (M/F): _____
4. Designation: _____
5. Organization: _____
6. Address for correspondence:

_____

_____

7. Email: _____
8. Phone/Mobile: _____
9. Highest Academic Qualification:_____
10. Specialization:_____
11. Details of fee payment (Reference no., date of payment, amount etc.): _____
12. Date: _____ Place:_____
13. Signature: _____

Continuing Education Programme (CEP)

Course on

Nonlinear Estimation for Engineers

1-5 February , 2020

(Call for Participation)

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Course Coordinators
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