

ASEN 6519: Advanced State Estimation

Spring 2021 Course Syllabus

General Information

Instructor: Prof. Nisar Ahmed (nisar.ahmed@colorado.edu)

Time and Location: Tues & Thurs 8:30 am - 9:45 am, AERO 114.

Course Website: canvas.colorado.edu (posted course materials, announcements, recorded lectures)

Office Hours: TBD (other times by appointment only)

Course Textbook:

B. Ristic, S. Arulampalam, N. Gordon, *Beyond the Kalman Filter: Particle Filters for Tracking Applications*, Artech House Radar Library, 2004, ISBN-13: 978-1580536318.

Description This new course will introduce students to principles and techniques for designing, implementing, and analyzing probabilistic state estimators for dynamical systems that require "going beyond" traditional least-squares and Kalman filtering approaches. Special emphasis will be placed on the development of practical discrete-time Bayesian state space filtering algorithms for systems that are characterized by partial observability and non-Gaussian uncertainties, which arise in many applications governed by complex non-linear stochastic dynamics and measurement processes. Topic coverage will include:

- Nonlinear least-squares and maximum likelihood estimation, Cramer-Rao bounds;
- Principles of Bayesian estimation theory and recursive Bayesian filtering;
- Statistical linearization and Unscented / Sigma Point filtering;
- Sequential Monte Carlo Particle filtering techniques;
- Gaussian mixture filtering and mixture condensation techniques;
- Multiple model filtering techniques for jump-Markov hybrid dynamics;
- Data association algorithms for tracking in clutter;
- Bayesian decentralized state estimation and data fusion with multiple networked filters;
- Highlights of other topics of as time/interest permits (e.g. intro to finite set statistics (FISST) and machine learning techniques).

Students will complete programming projects related to target tracking, vehicle navigation, localization, control, and other applications connected to their research or professional interests.

Prerequisites: (FIRM REQUIREMENTS)

Tentative Course Schedule (may vary somewhat)

Week(s)	Topic
1	Course intro & overview
1-3	

Following these safety measures, please see the "Accommodation for Disabilities" statement on this syllabus. Before returning to campus, all students must complete the COVID-19 Student Health and Expectations Course. **Before coming on to campus each day, all students are required to complete a Daily Health Form.**

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home and complete the Health Questionnaire and Illness Reporting Form remotely. In this class, if you are sick or quarantined, Faculty: insert your procedure here for students to alert you about absence due to illness or quarantine. Because of FERPA student privacy laws, do not require students to state the nature of their illness when alerting you.

ACCOMMODATION FOR DISABILITIES If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability Services website. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see Temporary Medical Conditions on the Disability Services website.

PREFERRED STUDENT NAMES AND PRONOUNS CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

HONOR CODE All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the -40917atheu foa-8(y)-3J 0

or cureport@colorado.edu. Information about the OIEC, university policies, anonymous reporting, and the campus resources can be found on the OIEC website.

Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

RELIGIOUS HOLIDAYS Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, you must notify the instructor at least 2 weeks in advance to schedule make up for completing and turning in exams and other assignments (see Course Details above).

See the campus policy regarding religious observances for full details.