OA3602
Search and Detection Theory

Course Syllabus

March 30, 2015

Contact Information

Instructor:	[redacted]
E-mail:	[redacted]
Office:	[redacted]
Phone:	[redacted]
Office Hours:	By appointment; I am usually available throughout the day

Course Goal

In this course students will learn how to apply quantitative models and modeling approaches to a broad range of real-world operational problems involving sensors and targets in order to evaluate effectiveness and/or optimally allocate resources.

Course Description

Search and detection as stochastic processes. Characterization of detection devices, use and interpretation of sweep widths and lateral range curves, true range curves. Measures of effectiveness of search-detection systems. Allocation of search efforts, sequential search. Introduction to the statistical theory of signal detection. Models of surveillance fields, barriers, tracking and trailing.

Learning Outcomes

Upon successful completion of this course, you should be able to:

- Characterize search and detection as processes governed by uncertainty.
- Recognize situations and assumptions underlying some classic search & detection models.
- Apply coverage, random search, barrier patrol, search allocation, and other search-theoretic models to real-world operational settings.
- Compute measures of performance associated with coverage, detection, and search problems, such as: time until complete coverage, probability of detection, and time until first detection.

- Analyze search and detection effectiveness for different types of sensors and sensor platforms, and for different types of targets, target behaviors, and target location uncertainty.
- Evaluate search plan courses of action.

Course Format

There will be a 50 minute lecture each day between Monday–Friday to introduce new material, reiterate the readings, and present examples. All relevant material will be posted on Sakai: `https://cle.nps.edu/`. This includes the readings, assignments, lecture notes, handouts, Excel files, code, and useful links.

Your grade will be determined by homework assignments, exams, and a project.

- Assignments. There will be approximately one homework assignment per week. The assignments will consists of mathematical problems related to the week's material.
- Project. There will be a group project that will require each group to select a problem, formulate a model, solve the model, present the results to the class, and write a report summarizing your results. The project will assess the student's ability to translate course concepts into operational scenarios and/or analytic contexts of interest. Self-selected teams will work together to conduct the project. Projects will be evaluated according to the given rubric. The project will be due in Week 8 (week of May 18)
- Exams. There will be two in-class exams. The first exam will will occur on April 24, and the second exam will occur on May 22. The exams are not cumulative. Each exam will consist of two parts
  - 25%: Each student will design, solve, and submit two candidate problems covering materials relevant to the exam prior to the exam date. Both a problem statement and a complete solution for each entry must be submitted, which will be evaluated according to the given rubric.
  - 75%: In-class exam. Some of the questions will be selected from the candidate problems submitted by the class.

Required Background

This course assumes a fundamental understanding of probability modeling and analysis and the ability to construct, implement, and analyze such models. Also, a basic competency in computation skills (in Python, R, Matlab, or similar) is expected. Computer labs in Glasgow and Learning Resource Centers across campus should have these software packages available for your use.

Prerequisite: Probability (OA3101) or Applied Probability for Systems Technology (OS2103), or consent of the instructor.

Keys to Success

- Take responsibility for your learning. Learning is something that happens between you (the student) and the material. The role of the instructor is to *organize the encounter* between you and material. But in the end, it's up to you.
- Attend class, ask questions, do the assignments, do the reading before class, come to office hours. Utilize all available resources.
- Take advantage of study groups. It is helpful to discuss this material. Studying with you peers can be an effective learning process. If you have additional questions or don't understand a topic, come see me.
- Come talk to me as soon as you feel lost. This class is fast-paced and if you fall behind early without doing anything about it, it will be difficult to catch up.
- Do not spend all of your time working on this course. If you have spent an hour working on a assignment or going over the material and have made little progress and are frustrated, then STOP working and come talk with me.

Textbooks

There is only one required text. It will be available on reserve in the library.

- *Search and Detection,*, 4th Edition (2002) Alan R. Washburn. Publisher: INFORMS (ISBN-10: 1877640174) `https://www.informs.org/Pubs/Topics-in-OR/Book-List/Search-and-Detection`

The following book is a useful reference and will be on reserve in the library.

- *Naval Operations Analysis*, 3rd Edition (1999), Daniel H. Wagner, W. Charles Mylander, Thomas J. Sanders. Publisher: Naval Institute Press (ISBN-10: 1591149509, ISBN-13: 978-1591149507)

Assessment

All work will be graded on a point scale (e.g., 21 out of 25).

Homework Assignments	25%
Exam 1	25%
Exam 2	25%
Project	25%

Late Policy

Unless you have made arrangements with me in advance, there will be a penalty for late submissions. Late projects will not be accepted. There will be a 20% deduction on homework turned in one day late, a 50% deduction for homework turned in two days late, and an 80% deduction for homework turned in more than two days late

Collaboration

Collaboration with other students is a valuable part of the learning process. Working together in collaborative groups is encouraged, as long as it provides an effective learning environment. All homeworks must be written individually. There is no collaboration allowed on exams. There are severe consequences for honor code violations. Please read the honor code on Sakai for further details. Any work that I deem to be in violation of the honor code will receive a 0.

Local Search Theory Experts

- [redacted]
- [redacted]
- [redacted]

Course Outline

This is a rough outline and will evolve as we progress through the quarter.

Week	*Topic*	*Reading*
1	Coverage, Imperfect Sensor Modeling	SD §1.1,2.1,2.2, NOA §5
2	Lateral Range Curves, Sweep Width	SD §2.4,4, NOA §6
3	Time-varying Coverage, Expanding Area Search, Trapping Circles	SD §1.5,1.6,2.3, NOA §7
4	Barrier Patrols	SD §1.3, NOA §9
5	Firing Theory, Fleeing Target	SD §1.4, NOA §12
6	Search Effort Allocation	SD §5, NOA §8
7	Detection Theory, ROC curves	SD §10
8	Sonar Models	SD §3, NOA §4

- SD: Washburn, *Search and Detection*
- NOA: Wagner, *Naval Operations Analysis*