ECE 621: System Identification

Spring 2017

Instructor: Balvinder Kaur, Ph.D.
E-mail: bkaur2@gmu.edu
Telephone: 703-993-1569

Class Location/Time: Robinson Hall A206/ Tuesday, 4:30 PM – 7:10 PM

Instructor Office Hours: Friday, 4:00 PM – 5:00 PM by appointment, Nguyen Engineering Bldg., RM 3707

Course Description: The central subject of the course is model building from experimental data. The basic approach is the method of least squares, of which several variants and extensions will be discussed. Subspace methods and principal component analysis will also be introduced and compared to least squares. The issues of excitation requirements, accuracy in the presence of noise, and computational algorithms will also be addressed. Course work will include several hands-on computer projects. Applications include engineering, economic and human systems and adaptive control.


Prerequisite(s): ECE 521 and 528, or permission of instructor.

Text:
- Lecture notes (available in book store)
- Other: Various journal articles.

Course Projects:
1. Basic LS algorithm, identifiability conditions.
2. Various recursive algorithms, forgetting factor.
3. Bias caused by noise, bias-free algorithms.

Course grade:
- 20% for each project (3) – Group Assignment
- 40% for individual semester long project:
  - Proposal and presentation (10%)
  - Project report, MatLab code, and final project presentation (30%)
George Mason University's Honor Code policies apply.

**Week-by-week schedule (tentative):**

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Topics Covered</th>
<th>Assignments Due</th>
</tr>
</thead>
</table>
| 1    | 24-Jan | * Introductions and Syllabus  
System Models, static models, dynamic models, input approximation; System Identification |                                  |
| 2    | 31-Jan | System Identification; Basic least-squares algorithms; Effects of noise; Insufficient Excitation  
*In-class paper review            |                                  |
| 3    | 7-Feb  | Effects of noise: Bias and uncertainty; Basic batch algorithm; Recursive algorithms; Forgetting factor  
*In-class paper review           |                                  |
| 4    | 14-Feb | Basic Least Squares Identification Techniques; MA Dynamic System; ARMA Dynamic System; Computational Algorithms  
*In-class paper review           |                                  |
| 5    | 21-Feb | Persistent Excitation; Excitation Properties of common signals;  
*Individual Project - Proposal Presentations | Individual Project Proposal     |
| 6    | 28-Feb | Over-parametrization; feed-back, effects of noise, variance of estimates;  
*Project Presentation           | Group Project 1                  |
| 7    | 7-Mar  | Generalized Least Squares (GLS) Method; Instrumental variable (IV) method;  
*Guest Speaker                  | Guest Speaker                    |
| 8    | 14-Mar | Spring Break (No Class)                                                                          |                                  |
| 9    | 21-Mar | Recursive IV algorithm; Instrumental variable in closed loop;  
*In-class paper review           |                                  |
| 10   | 28-Mar | Output error (OE) LS algorithm; Newton-Raphson Technique; convergence issues  
*Project Presentation           | Group Project 2                  |
| 11   | 4-Apr  | Principal Component Analysis (PCA)  
*In-class paper review          |                                  |
| 12   | 11-Apr | Work on Individual Projects (No Class)                                                           |                                  |
| 13   | 18-Apr | Dynamic Principal Component Analysis (D-PCA)  
*Individual Project Presentations | Individual Project Report       |
| 14   | 25-Apr | Dynamic Principal Component Analysis (D-PCA)  
*Guest Speaker                  | Guest Speaker                    |
| 15   | 2-May  | Independent component analysis (ICA).  
*In-class paper review           |                                  |
| 16   | 9-May  | Nonlinear systems; Electro-optical imaging systems  
*Project Presentation           | Group Project 3                  |