Digital Signal Processing

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Lecture 1 (Intro and Matlab)

January 13th, 2016

The following references have been used in this presentation: [1] Sanjit Mitra, "Digital Signal Processing–A Computer Based Approach". [2] John Proakis and Dimitris K Manolakis "Digital Signal Processing". [3] Notes by Prof. Dan Elis at Columbia University.

Outline

- What to expect from the course
- Evaluation
  - Homework
  - Project
  - Midterm
  - Final exam
- Matlab

Instructor

- ✓ Raised in British Columbia, Canada.
- ✓ Completed Ph.D. in August of 2010, at Queen's University.
- ✓ Completed Post-Docs at Chalmers University of Technology and the University of Luxembourg.
- ✓ Currently an assistant professor at CSUB.
- ✓ Research Interests:
  - Application of signal processing algorithms in communication systems.
  - Cooperative communication systems.
  - Heterogeneous networks.
  - Synchronization and channel estimation.
  - Millimeter wave communication systems.
  - Large-scale multiple antenna wireless systems.

Lectures

Weds, Fridays,

9:00-10:15 PM

Mission

Introduction to principles of Digital Signal Processing (DSP) including sampling theory, aliasing effects, frequency response, Finite Impulse Response filters, Infinite Impulse Response filters, spectrum analysis, Z transforms, Discrete Fourier Transform and Fast Fourier Transform. Overviews of modern DSP applications such as modems, speech processing, audio and video compression and expansion, and cellular protocols. Four hours lecture/discussion and three hours laboratory per week.

Text Books

- **Main book:** "Digital Signal Processing", 4th Edition, Authors: John Proakis and Dimitris K Manolakis.
  - Fundamental book with more details and analysis and also lots of examples.
- **Main book:** "Digital Signal Processing–A Computer Based Approach", 4th edition, Author: Sanjit Mitra.
  - Good book with lots of examples and applications via Matlab.
- **Supplementary book:** "Schaums Outline of Digital Signal Processing", 2nd Edition, Author: Monson Hayes, (2nd Edition)".
  - Lots of solved problems which is key to grasping the topics

Means of Communication

- **Website**
  - Lectures, labs, all materials related to the course will be posted here. www.mehrpouyan.info.
  - I will try to post the slides before the lectures.
- **Office hours**
  - They are scheduled for 2:15-3:15 on Thursdays.
- **Email**
  - You can email me at any time and I will try to do my best to answer your question or schedule you in for a meeting. hani.mehr@ieee.org

Homework

- 20% of your total mark.
- Homework is due on every Wednesday at the beginning of each lecture. Please consult the handout for the exact due dates.
- Based on general problems and will be from the textbook. They also include Matlab exercises.
- Late homework will not be accepted no exceptions applied. I am sorry but we need to be fair. The following constitutes as a late submission :
  - Hand-in your homework at the end of the lecture on Wed.
  - Hand-in your homework at the end of the day.
  - Hand-in your homework because you are sick with no Dr.'s note.

Group Project

- 25% of your total mark is allocated to the group project.
- Programing project preferably with Matlab.
- Given that you have the span of a whole quarter to apply the principles of signal processing, the project provides a great learning experience.
- You will work on the project in groups of 2. The best arrangement would be to have you each work on a specific segment of the project to ensure its successful completion. Teamwork is an important aspect of this project and will be used for evaluation purposes.
- You can pick your own topic for the project and confirm it with me. Please do this via email. Send me a brief abstract of what you plan to do.

Group Project

- Some project ideas are posted on the website. These are only suggestions to help you with the topic selection. You do not have to focus on them and can work on a completely new topic that is of interest to you, as long as, I approve it.
- The course is focused on signal processing so the main requirement for your project is that you analyze and manipulate some form of a signal. This is not supposed to be a purely theoretical experiment. Hence, I would like you to focus on practical signals. These signals can be from real sources or can be synthetic. Th real signals need to be acquired from measurment and maybe hard to come by. Hence, you may generate synthetic signals by starting from an ideal signal and adding noise to it.
- I strongly recommend that you use Matlab and its built in toolboxes.

Group Project

- The projects will be graded based on a project report (of around 5 pages), as well as, an in-class presentation.
- Your report must have the following structure, containing the following sections:
  - **Abstract:** a brief abstract of what you are planning.
  - **Introduction:** A general description of the area of your project and why you're doing it.
  - **Problem Description:** A clear and succinct technical description of the problem you're addressing. Formulating a general problem, e.g., image processing, into a well-defined technical goal.
  - **Data:** What are the real-world and/or synthetic signals you are going to use to develop and evaluate your work?
  - **Evaluation Criteria:** How are you going to evaluate the performance of your proposed signal processing algorithm? The best criteria are objective, quantitative, and discriminatory. You want to be able to demonstrate and measure improvements in your system.
  - **Proposed Solution:** A description of the approach that was used to solve the proposed problem. Sometimes once can enhance the project's contributions by contrasting two or more different approaches.

Group Project

- Your report must have the following structure, containing the following sections:
  - **Simulations and Analysis:** What happened when you evaluated your system using the data and criteria introduced above? What were the principal shorfalls? (This may require you to choose or synthesize data that will reveal these shortcomings.) Your analysis of what happened is one of the most important opportunities to display your command of signal processing concepts.
  - **Development:** If possible, you will come up with ideas on how to improve the shortcomings identified in the previous section, and then implement and evaluate them. Did they, in fact, help? Were there unexpected side-effects?
  - **Conclusions:** What did you learn from doing the project? What did you demonstrate about how to solve your problem?
  - **References:** Complete list of sources you used in completing your project, with explanations of what you got from each.

Group Project

- This structure is used to help you avoid some of the more problematic weaknesses. If you are having trouble fitting your work into these sections, you should probably think more carefully about your project. If you have a good reason for deviating from this structure, talk to me.

Time line

Wednesday	Friday	Thursday
13-Jan-16	15-Jan-16	14-Jan-16
Lecture 1	Lecture 2	Office Hour 1
3:15-4:55	3:15-4:55	14:15-15:15
Introduction	Introduction to Discrete Time Signals	
Wednesday	**Friday**	**Thursday**
20-Jan-16	22-Jan-16	21-Jan-16
Lecture 3	Lecture 4	Office Hour 2
3:15-4:55	3:15-4:55	14:15-15:15
Homework 1		
Time Domain Processing: Convolution and Correlation	Time Domain Processing: Convolution and Correlation	
Wednesday	**Friday**	**Thursday**
27-Jan-16	29-Jan-16	28-Jan-16
Lecture 5	Lecture 6	Office Hour 3
3:15-4:55	3:15-4:55	14:15-15:15
Homework 1 due		
Homework 2		
Fourier Domain, Discrete-Time Fourier Transform and DFT	Fourier Domain, Discrete-Time Fourier Transform and DFT	
Wednesday	**Friday**	**Thursday**
3-Feb-16	5-Feb-16	4-Feb-16
Lecture 7	Lecture 8	Office Hour 4
3:15-4:55	3:15-4:55	14:15-15:15
Homework 3		
Homework 2 due		
The Z Transform	The Z Transform	

Time line

Wednesday	Friday	Thursday
10-Feb-16	12-Feb-16	11-Feb-16
Lecture 9	Lecture 10	Office Hour 5
3:15-4:55	3:15-4:55	14:15-15:15
Homework 3		
Homework 3 due		
Transform Domain Systems	Transform Domain Systems	
Wednesday	**Friday**	**Thursday**
17-Feb-16	19-Feb-16	18-Feb-16
Lecture 11	Lecture 12	Office Hour 6
3:15-4:55	3:15-4:55	14:15-15:15
Simple Filters and Linear Phase	Midterm 1	

Time line

Wednesday	Friday	Thursday
24-Feb-16	26-Feb-16	25-Feb-16
Lecture 13	Lecture 14	Office Hour 7
3:15-4:55	3:15-4:55	14:15-15:15
Homework 4		
Filter Structures	Filter Structures	
Wednesday	**Friday**	**Thursday**
2-Mar-16	4-Mar-16	3-Mar-16
Lecture 15	Lecture 16	Office Hour 8
3:15-4:55	3:15-4:55	14:15-15:15
Homework 5		
Homework 4 due		
IIR	IIR	
Wednesday	**Friday**	**Thursday**
9-Mar-16	11-Mar-16	10-Mar-16
Lecture 17	Lecture 18	Office Hour 9
3:15-4:55	3:15-4:55	14:15-15:15
Homework 6		
Homework 5 due		
FIR Filters	FIR Filters	

Time line

Wednesday	Friday	Thursday
16-Mar-16	18-Mar-16	17-Mar-16
Lecture 19	Lecture 20	Office Hour 10
3:15-4:55	3:15-4:55	14:15-15:15
Homework 7		
Homework 6 due		
Fast Fourier Transform	Fast Fourier Transform	
Wednesday	**Friday**	**Thursday**
23-Mar-16	25-Mar-16	24-Mar-16
Lecture 19	Lecture 20	Office Hour 10
3:15-4:55	3:15-4:55	14:15-15:15
Homework 8		
Homework 7 due		
Spring Break	Spring Break	
Wednesday	**Friday**	**Thursday**
30-Mar-16	1-Apr-16	31-Mar-16
Lecture 19	Lecture 20	Office Hour 10
3:15-4:55	3:15-4:55	14:15-15:15
Interfacing to continuous time	Midterm 2	

Time line

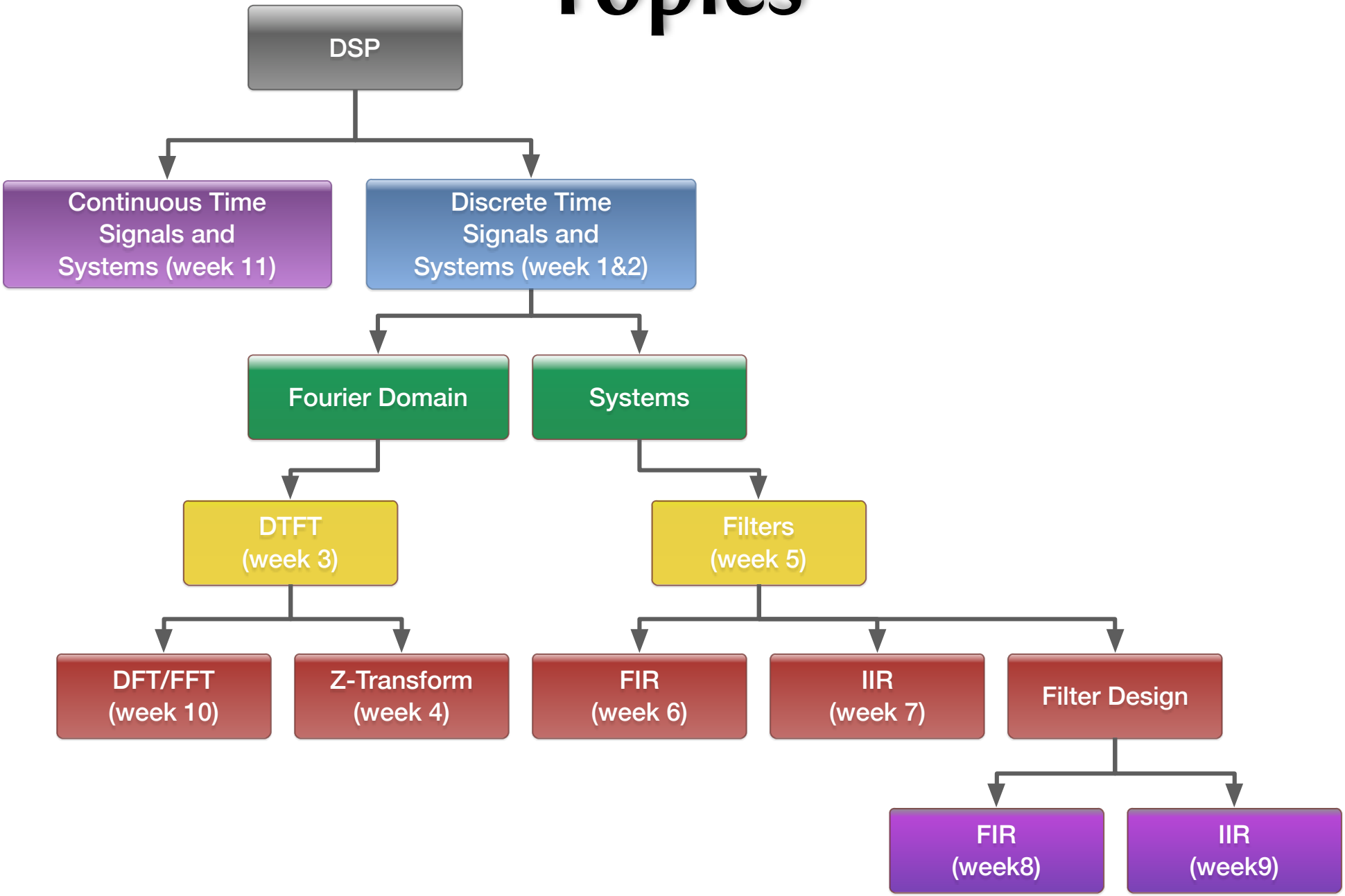
Wednesday	Friday	Thursday
6-Apr-16	8-Apr-16	7-Apr-16
Lecture 19	Lecture 20	Office Hour 10
3:15-4:55	3:15-4:55	14:15-15:15
Homework 9		
Homework 8 due		
Linear Prediction and Optimum Linear Filters	Linear Prediction and Optimum Linear Filters	
Wednesday	**Friday**	**Thursday**
13-Apr-16	15-Apr-16	14-Apr-16
Lecture 19	Lecture 20	Office Hour 10
3:15-4:55	3:15-4:55	14:15-15:15
Homework 10		
Homework 9 due		
Adaptive Filtes	Adaptive Filtes	

Time line

Wednesday	Friday	Thursday
20-Apr-16	22-Apr-16	21-Apr-16
Lecture 19	Lecture 20	Office Hour 10
3:15-4:55	3:15-4:55	14:15-15:15
Homework 11		
Homework 10 due		
Presentations	Presentations	

Wednesday	Friday	Thursday
27-Apr-16	29-Apr-16	28-Apr-16
Lecture 19	Lecture 20	Office Hour 10
3:15-4:55	3:15-4:55	14:15-15:15
Presentaitons	Presentations	
6-May-16		
Final Exam		
10:00-12:00 PM		

Topics


DSP
Continuous Time Signals and Systems (week 11)
Discrete Time Signals and Systems (week 1&2)
Fourier Domain
Systems
DTFT (week 3)
Filters (week 5)
DFT/FFT (week 10)
Z-Transform (week 4)
FIR (week 6)
IIR (week 7)
Filter Design
FIR (week8)
IIR (week9)