EE599 Graph Signal Processing

Course Syllabus

Term: Spring 2022 — Updated January 7, 2022[1]

Units: 2

Prerequisite: Basic linear algebra (EE 141L) and Matlab programming (or instructor permission).

Recommended preparation: Linear Algebra (EE 510), Signal Processing (EE 301, EE 483)

Goals: In the last 10 years there has been an increased interest in developing a better understanding of processing of signals living on graphs. Applications include analysis of sensor data, image processing and machine learning. Research in graph signal processing (GSP) has made significant progress towards developing tools similar to those used in conventional signal processing, including definition of notions of graph frequencies, graph filters, sampling, graph learning, etc.

In this class we will provide an overview of the state of the art of graph signal processing. Specific topics include:

- fundamental graph operators and graph frequencies;n
- graph signal representations and sampling;
- graph learning from data;
- application of these concepts to sensor data, image, video and point cloud processing.
- graph convolutional networks.

We will make use of existing GSP programming tools.

Instructor: Prof. Antonio Ortega, Dept. of Electrical and Computer Engineering, EEB 436 E-mail: aortega@usc.edu

Lecture: Friday, 12:00-1:50pm, CPA 205 + Online

Office Hours: TBD

Teaching Assistant: TBD

Midterms: There will be one midterm exam and one class project

Grading: Homework/Participation (10%), Midterm 1 (45%), Project (45%).

Textbooks and other materials:

- Antonio Ortega, *Graph Signal Processing: An Introduction*, Cambridge University Press, 2021. `http://www.graph-signal-processing-book.org` (In short, "AO")
- We will also use research papers to cover specific topics, including recent overview papers in the IEEE Signal Processing Magazine. Some of the relevant papers can be found here: `https://www.graph-signal-processing-book.org/references.html`.

[1]This syllabus is subject to change and will be updated.

Tentative Schedule:

- Week 1: Introduction to graphs and applications (AO Ch 1)
- Week 2: Review linear algebra – Overcomplete expansions and dictionaries (AO Appendix A)
- Weeks 3-4: Node domain signal processing (AO Ch 2)
- Week 5-6: Spectral domain signal processing (AO Ch 3)
- Week 7-8: Graph signal sampling (AO Ch 4, [Tanaka et al, 2020])
- Week 9-10: Graph signal representations (AO Ch 5, [Shuman 2020])
- Week 11-12: Graph learning (AO Ch 6, [Dong et al,2019, Mateos et al, 2019])
- Week 13-14: Applications (AO Ch 7, multiple papers)
- Week 15: Project presentations

Statement for Students with Disabilities: Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. Website and contact information for DSP:
`http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html`,
(213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX) ability@usc.edu.

Statement on Academic Integrity: USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. SCampus, the Student Guidebook, (www.usc.edu/scampus or http://scampus.usc.edu) contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.