PURDUE
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ECE642 Information Theory and Source Coding
Syllabus
Fall 2022

Course Information

ECE642 Information Theory and Source Coding

CRN's:

  In-person: 29389
  Online   : 29914
  EPE   : 29918

Meeting time: Tuesdays and Thursdays at 3:00 pm - 4:15 pm
Location: MSEE B010
Course credit hours: 3
Course web page: https://www.muratkocaoglu.com/ece642

The information in this syllabus is subject to change as needed in response to unexpected developments, although the instructor will attempt to avoid disruptions as much as possible.

Information about the Instructor(s)
Prof. Murat Kocaoglu
Office: MSEE 362
Email: mkocaoglu@purdue.edu

Lectures
Lectures will be delivered in-person and will be recorded and uploaded for students attending remotely.

Office Hours
Prof. Murat Kocaoglu   Friday 4:00-5:00pm at MSEE 362 for on-campus students.
                                           Monday 4:00-5:00pm online over Zoom. Open to all but distance students get priority.

Course Description
Information theory has revolutionized several fields from communication to storage. We will cover the mathematical theory of information by Claude E. Shannon. Some core concepts are entropy, mutual information, conditional mutual information. We will discuss source and channel coding theorems and their converses.

Learning Outcomes
A student who successfully fulfills the course requirements will have demonstrated an ability to represent information and uncertainty mathematically, how to process realizations of random data sources efficiently and how

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to encode them to send over a communication channel and decode. They will develop an understanding of the fundamental mathematical limits of compressing a random source, and rate with which they can communicate a random source on a communication channel.

Piazza

Piazza will be used as an online forum for discussions. The main goal of Piazza is to provide a platform for the students to discuss topics, answer each others' questions to clarify minor points, while the instructor provides supervision to ensure the answers are sound.

Please sign up for Piazza from the following link, using the access code posted on Brightspace.
http://piazza.com/purdue/fall2022/ece642?token=5XeItqUr78a

Textbook

The main textbook is *Elements of Information Theory by Cover and Thomas, Wiley, 2nd Edition*. Some topics on source coding methods will follow *Vector Quantization and Signal Compression by Gersho and Gray, Springer, 1991*.

Assignments and Points

Two midterms each worth 25% of your final grade, a final worth 30% of your final grade, and bi-weekly homeworks worth 15% of your final grade. Class and Piazza participation amounts to 5% of your final grade.

Midterm 1: 25%
      Date   : TBD
      Format : Take-home. Open-notes/book. <u>Collaboration, and the use of online resources is strictly prohibited.</u>

Midterm 2: 25%
      Date   : TBD
      Format : Take-home. Open-notes/book. <u>Collaboration, and the use of online resources is strictly prohibited.</u>

Final: 30%
      Date   : tbd
      Format : Take-home. Open-notes/book. <u>Collaboration, and the use of online resources is strictly prohibited.</u>

Homeworks: 15%
      Bi-weekly homeworks will be graded roughly. The instructor may resort to a detailed evaluation of the homeworks for borderline cases at the end of the semester. Students are allowed to collaborate for homeworks; however, each student needs to write their own solution and submit a separate homework. Furthermore, each student should write their collaborator's names in their homework submission; students who fail to do so will all receive zeroes for that assignment.

In-class or Attendance: 5%
      Depending on the level of participation of the students in in-class discussions, or them answering questions on Piazza and participating in online discussions

Grading Scale

100   : A+
90–99 : A
85-90 : A-
80-85 : B+
75–80 : B

70-75 : B-
60–70 : C
50–60 : D
0–50 : F

Instructor reserves the right to be more generous with the final grading scale depending on the class average.

Incomplete Grades
A grade of incomplete (I) will be given only in unusual circumstances. To receive an "I" grade, a written request must be submitted prior to December 1, and approved by the instructor. The request must describe the circumstances, along with a proposed timeline for completing the course work. Submitting a request does not ensure that an incomplete grade will be granted. If granted, you will be required to fill out and sign an "Incomplete Contract" form that will be turned in with the course grades. Any requests made after the course is completed will not be considered for an incomplete grade.

Attendance Policy
Attendance is not mandatory. However, students are expected to attend in-person lectures and participate to the discussions to succeed in the course.

Academic Integrity
Any student found cheating in any way on the exam, class project or any other assignment will fail the class and be reported to the dean.

Nondiscrimination Statement
Purdue University is committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. Link to Purdue's nondiscrimination policy statement.

Accessibility
Purdue University is committed to making learning experiences accessible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let the instructor know to discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247. If you have a letter of accommodation from the disability resources center (DRC), please send it to Prof. Murat Kocaoglu.

Emergency Preparation
In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructor via email. You are expected to read your @purdue.edu email on a frequent basis.

See emergency plans for Hampton Hall building with your Purdue credentials:
https://www.purdue.edu/ehps/emergency_preparedness/bep/HAMP-bep.html

In the Event a Student is Quarantined/Isolated

If a student is quarantined and unable to physically participate in the course, the instructor will take the necessary steps for them to complete the course remotely to the best of his abilities. This involves, but is not limited to, having the student present remotely, take the midterm at home and providing remote office hours.

Classroom Guidance Regarding Protect Purdue

Any student who has substantial reason to believe that another person is threatening the safety of others by not complying with Protect Purdue protocols is encouraged to report the behavior to and discuss the next steps with their instructor. Students also have the option of reporting the behavior to the Office of the Student Rights and Responsibilities. See also Purdue University Bill of Student Rights and the Violent Behavior Policy under University Resources in Brightspace.

Basic Needs Security

Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students 8 a.m.-5 p.m. Monday through Friday. Considering the significant disruptions caused by the current global crisis as it related to COVID-19, students may submit requests for emergency assistance from the Critical Needs Fund.

Mental Health Statement

- **If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack.** Sign in and find information and tools at your fingertips, available to you at any time.
- **If you need support and information about options and resources**, please see the Office of the Dean of Students for drop-in hours (M-F, 8 am- 5 pm).
- **If you're struggling and need mental health services**: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office of the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Wellness

TaskHuman offers private, real-time, on-demand, 1-on-1 video calls with wellness coaches covering over 800+ topics such as anxiety, mindfulness, reducing stress, clean eating, time management, in-home workouts, relationship tensions, financial issues, spiritual guidance and many more. You can access these wellness coaches from around the world 24/7. The College of Engineering has an exclusive agreement with TaskHuman which gives you FREE and UNLIMITED access to these resources. Over 3,200 calls have been made by College of Engineering students, staff, and faculty so far with an average satisfaction rating of 4.89/5. Learn more here: https://engineering.purdue.edu/ECE/TaskHuman

Course Schedule (Tentative)

This is a new course. The instructor can make adjustments to the coverage time of different topics based on his interactions with the students and in-class impressions.

Week	Date	Topic
1	8/23	Introduction, Measuring Information and Randomness, Models for Communication Channels
1	8/25	Probability Theory, Convex Functions, and Limits Recap
2	8/30	Recap (Cont'd)
2	9/1	(Conditional) Entropy, Relative Entropy, (Conditional) Mutual Information
3	9/6	Chain Rule, Data Processing Inequality, Fano's Inequality
3	9/8	Asymptotic Equipartition Property, Typical Sequences
4	9/13	Source Coding Theorem
4	9/15	Source Codes, Kraft Inequality, McMillan Inequality
5	9/20	Shannon-Fano Codes, Huffman Codes, Universal Source Coding
5	9/22	Discrete Memoryless Channels, Channel Capacity
6	9/27	Channel Coding Theorem
6	9/29	Channel Coding Theorem (Cont'd)
7	10/4	No class due to midterm [Take-home, open notes, open book.]
7	10/6	Error Control Coding, Capacity of Channels with Feedback
8	10/11	OCTOBER BREAK
8	10/13	Differentiable Entropy, Mutual Information for Continuous Random Variables
9	10/18	Capacity of Gaussian Channels
9	10/20	Parallel Gaussian Channels, Water-filling Theorem
10	10/25	Rate Distortion Theory
10	10/27	Rate Distortion Theory (cont'd)

11	11/1	No class due to midterm [Take-home, open notes, open book.]
11	11/3	Source-channel Coding Theorem
12	11/8	Universal source coding
12	11/10	Scalar Quantization, Differential Encoding,
13	11/15	Differential Pulse-coded Modulation, Delta Modulation
13	11/17	Lloyd-Max Quantization Algorithm
14	11/22	Integer-constrained Encoding Bit Allocation for Quantization,
14	11/24	THANKSGIVING
15	11/29	Transform Coding
15	12/1	Vector Quantization
16	12/6	Generalized Lloyd-Max Algorithm
16	12/8	Summary and Closing Remarks