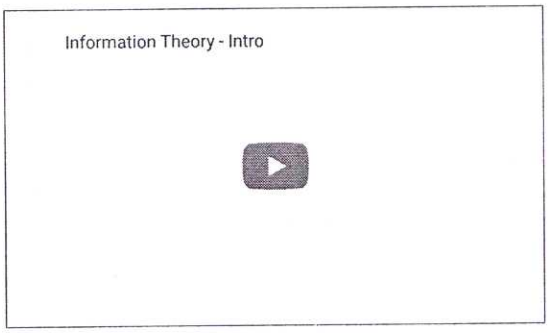
Information Theory

By Prof. Himanshu Tyagi | IISc Bangalore

Go to course (course?user_email=tulasi0210@gmail.com) Learners enrolled: 1971



This is a graduate level introductory course in Information Theory where we will introduce the mathematical notion of information and justify it by various operational meanings. This basic theory builds on probability theory and allows us to quantitatively measure the uncertainty and randomness in random variable, as well as information revealed or

Summary

Course Status :	Completed
Course Type :	Elective
Duration :	12 weeks
Category :	• Electrical, Electronics and Communications Engineering • Communication and Signal Processing
Credit Points :	3
Level :	Undergraduate/Postgraduate
Start Date :	14 Sep 2020
End Date :	04 Dec 2020

... We will encounter quantities such as entropy, mutual information, ... ance, and KL divergence and explain ... communication, statistics, and computer science.Information theory was originally invented as a mathematical theory of communication, but has since found applications in many areas ranging from physics to biology. In fact, any field where people want to evaluate how much information about an unknown is revealed by a ... information theory can help. In this course, we will lay down the foundations of this fundamental field.

(https://swayam.gov.in/nc_details/NPTEL)

INTENDED AUDIENCE : Senior undergraduate and graduate students interested in probability, statistics, communication, theoretical computer science, machine learning, quantum information and statistical physics

PREREQUISITES : Undergraduate level probability (sets and events, probability distributions, probability density functions, probability mass functions, random variables, expected value, variance, popular probability laws, Markov inequality, Chebyshev inequality, central limit theorem, law of large numbers)

INDUSTRIES SUPPORT : None

Enrollment Ends : 25 Sep 2020

Exam Date : 20 Dec 2020 IST

Note: This exam date is subjected to change based on seat availability. You can check final exam date on your hall ticket.

This is an AICTE approved FDP course

Course layout

This course is organised into multiple units. While I have tried my best to align units to weeks, for sometimes we will cover parts of multiple units in the same week. We will provide

Week 1: (Unit 1) Information and probabilistic modelling: information, uncertainty, basic concepts of probability, Markov inequality, limit theorems

Week 2: (Unit 2) Uncertainty, compression, and entropy: source model, motivating examples, a compression problem, Shannon entropy, random hash

Week 3: (Unit 3) Randomness and entropy: uncertainty and randomness, Total variation distance, generating uniform bits, generating from uniform bits, typical sets and entropy

Week 4: (Unit 4) Information and statistical inference-1: Hypothesis testing and estimation: examples, the log-likelihood ratio test, Kullback-Leibler divergence and Means

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of KL divergence

formation and statistical inference-2 testing, mutual information, Fano's inequality

Week 6: (Unit 6) Properties of measures of information-1: Definitions, chain rule, shape of information functions (boundedness, concavity/convexity, non negativity), data processing inequality

Week 7: (Unit 7) Properties of measures of information-2: Proof of Fano's inequality, variational formulae, capacity as information radius, proof of Pinsker's inequality, continuity of entropy, (Unit 8) Information theoretic lower bounds: Lower bound for source coding, lower bound for Stein's lemma

Week 8: (Unit 8 continued): lower bound for randomness generation, strong converse, lower bound for minimax estimation, (Unit 9) Compression 1: Variable length source codes

Week 9-12: We will post the exact plan soon. Basically, we will cover compression, channel coding, and quantisation in the remaining 4 weeks.

Books and references

1. T. Cover and J. Thomas, Elements of Information Theory, Second edition, Wiley, 2006
2. I. Csiszar and J. K. orner, Information Theory: Coding Theorems for Discrete Memoryless Systems, Second edition, Cambridge, 2011.
3. T. S. Han, Information-spectrum methods in Information Theory, Stochastic Modeling and Applied Probability series, Springer, 2003.
4. J. Wolfowitz, Coding Theorems of Information Theory, Probability Theory and Stochastic Processes series, Springer, 1978
5. A. Khinchin, Mathematical foundations of information theory, Dover, 2007 edition

Instructor bio

Assistant Professor Department of Electrical Communication Engineering Participating Faculty Robert Bosch Center for Cyber Physical Systems Member Faculty Analysis and Probability Research Group (APRG)

Course certificate
(https://swayam.gov.in/nc_details/NPTEL)

•The course is free to enroll and learn from. But if you want a certificate, you have to register and write the proctored exam conducted by us in person at any of the designated exam centres.
•The exam is optional for a fee of Rs 1000/- (Rupees one thousand only)
• **Date and Time of Exams: 20 December 2020, Morning session 9am to 12 noon; Afternoon Session 2pm to 5pm.**
•Registration will be announcements will be made when the registration form is open for registrations.
• The online registration form has to be filled and the certification exam fee needs to be paid. More details will be made available when the exam registration form is published. If there are any changes, it will be mentioned then.
•Please check the form for more details on the cities where the exams will be held, the conditions you agree to when you fill the form etc.

CRITERIA TO GET A CERTIFICATE:
• Average assignment score = 25% of average of best 8 assignments out of the total 12 assignments given in the course.
• Exam score = 75% of the proctored certification exam score out of 100
•Final score = Average assignment score + Exam score

YOU WILL BE ELIGIBLE FOR A CERTIFICATE ONLY IF AVERAGE ASSIGNMENT SCORE >=10/25 AND EXAM SCORE >= 30/75.
•If one of the 2 criteria is not met, you will not get the certificate even if the Final score >= 40/100.
• Certificate will have your name, photograph and the score in the final exam with the breakup. It will have the logos of NPTEL and IISc Bangalore. It will be e-verifiable at nptel.ac.in/noc (http://nptel.ac.in/noc)
•Only the e-certificate will be made available. Hard copies will not be dispatched.

NPTEL-AICTE
Faculty Development Programme

(Funded by the Ministry of HRD, Govt. of India)

This certificate is awarded to

B.TULASI SOWJANYA

for successfully completing the course

An Introduction to Information Theory

with a consolidated score of **62** %

Prof. Andrew Thangaraj
NPTEL Coordinator
IIT Madras

(Aug-Sep 2018)

Prof. Dileep N. Malkhede
Advisor-I (Research, Institute & Faculty Development)
All India Council for Technical Education

Roll No: NPTEL18EE49S11340207

To validate and check scores: http://nptel.ac.in/noc

The candidate has studied the above course through MOOCs mode, has submitted online assignments and passed proctored exams.
This certificate is therefore acceptable for promotions under CAS as per AICTE notifications dated 24th July 2018, similar to other refresher / orientation courses.
F.No. AICTE / RIFD / FDP through MOOCs / 2017-18

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Department: Electronics and Communication Engineering

Report on

FDP on "**An Introduction to Information Theory**"

Academic year: 2018-2019

Dates of the program: 8 Weeks NPTEL Course equivalent of AICTE Approved 1 week FDP conducted during Aug-Sep 2018.

Resource persons: Prof. Adrish Banerjee, IIT Kanpur

About the Program:

Information Theory answers two fundamental questions: what is the maximum data rate at which we can transmit over a communication link, and what is the fundamental limit of data compression. In this course we will explore answers to these two questions. The course focussed on some practical source compression algorithms. The course will also provide some insights on how to compute channel capacity of simple channels.

Course layout

Week 1: Introduction: Entropy, Relative Entropy, Mutual Information; Information Inequalities;

Week 2: Block to variable length coding-I: Prefix-free code, Block to variable length coding-II: Bounds on optimal codelength; Block to variable length coding-III: Huffman coding.

Week 3: Variable to block length coding, The asymptotic equipartition property, Block to block coding of DMS

Week 4: Universal Source Coding-I: Lempel-Ziv Algorithm-LZ77, Universal source coding-II: Lempel-Ziv Welch Algorithm (LZW)

Week 5: Coding for sources with memory, Channel capacity of discrete memoryless channels.

Week 6: Joint typical sequences, Noisy channel coding theorem, Differential entropy

Week 7: Gaussian Channel, Parallel Gaussian Channel.

Week 8: Rate Distortion Theory, Blahut-Arimoto Algorithm for computation of channel capacity and rate- distortion function.

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Signature of the Faculty member