

Lecture 0: Introduction

Yi, Yung (이용)

EE210: Probability and Introductory Random Processes
KAIST EE

August 22, 2022

- Course logistics
- Why this course?

August 22, 2022 1 / 19

August 22, 2022 2 / 19

Instructor

- Yi, Yung (이용)
- Office: N1, 810
- Homepage: <https://yung-web.github.io/home/>
- E-mail: yiyung@kaist.edu
- Computer Division
- In KAIST EE since 2008

- non-real-time online ($\leq 50\%$) + real-time offline/online ($\geq 50\%$)
- All lecture videos have already been pre-recorded. Available in [YouTube](#).
- **non-real-time online:** Just watch anytime and anywhere you like.
- **realtime offline/online:** Watch lecture videos in the classroom or in the zoom, with [asking and answering questions](#).
- No attendance check!

August 22, 2022 3 / 19

August 22, 2022 4 / 19

- Method 1:
<https://yung-web.github.io/home/courses/probability.html>
- Method 2: (a) Type **Yung Yi** in the google, (b) visit his [GitHub homepage](#), (c) find the links on [Course](#).

Google Search Results for 'yung yi':

- <https://yung-web.github.io/home/courses/probability.html>
- [Yung Yi - KAIST ELECTRICAL ENGINEERING](#)
- [Yung Yi | GitHub Pages](#)
- [Yung Yi | OpenReview](#)
- [Yung Yi - Home - ACM Digital Library](#)

Yung Yi's GitHub Profile Page:

Courses

- Probability and Random Processes (Undergraduate)
- Mathematics for Data Science (Undergraduate)
- Computer Network (Undergraduate)
- Game Theory (Undergraduate)

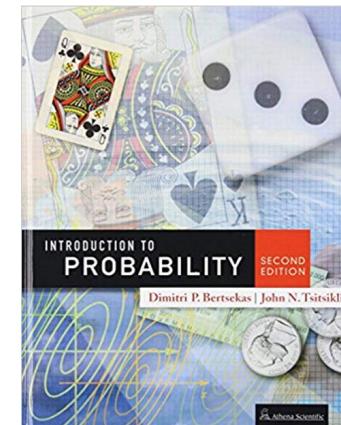
- All notifications and announcements (also sent to you via email)
- Questions about course contents
 - Only through posting in KLMS (so should be in English)
 - NOT individual emails to the lecturer or the TAs
- Homework upload
- Score upload and all the grade-related things

August 22, 2022 5 / 19

August 22, 2022 6 / 19

Textbook

- Introduction to Probability (2nd edition)
 - MIT course textbook
 - Dimitri P. Bertsekas and John N. Tsitsiklis
- You can order it from Yes24, Aladin, Kyobo
 - Yes24: <http://www.yes24.com/Product/Goods/3995311>
 - Aladin: <https://www.aladin.co.kr/shop/wproduct.aspx?ItemId=12945615>
 - Kyobo: <http://www.kyobobook.co.kr/product/detailViewEng.laf?ejkGb=ENG&mallGb=ENG&barcode=9781886529380&orderClick=LAG&Kc=>



- <http://athenasc.com/probbook.html>
- Problem solutions
- Links to the MIT courses
- You can find the urls (2006, 2010, 2013) for the MIT lectures based on the same textbook, where there are many useful resources (recitation problems, homework problems, old exam problems, etc)
- Some of my lecture slides are based on theirs, but my slides are largely modified/reorganized/edited in many places for our purpose.

August 22, 2022 7 / 19

August 22, 2022 8 / 19

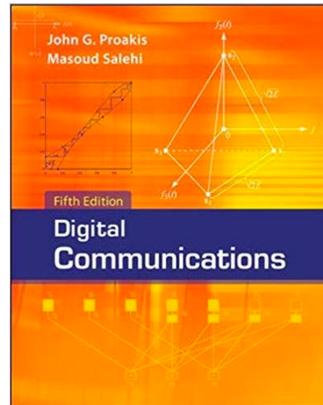
1. Probabilistic model (1/2 week)
2. Conditioning and Independence (1/2 week)
3. Random Variable, Part I (Discrete Random Variable) (1.5 week)
4. Random Variable, Part II (Continuous Random Variable) (1.5 week)
5. Random Variable, Part III (Advanced Topic on Random Variable) (1.5 week)
6. Limit of Scaled Sum of Random Variables: Central Limit Theorem and Weak Law of Large Numbers (1.5 week)
7. Random Process: Bernoulli and Poisson Processes (2 week)
8. Random Process: Markov Chain (2 week)
9. Introduction to Statistical Inference (2 week)

- 2 Exams (mid-term and final)
- Homeworks
 - All problems are from exercise problems in the textbook.
 - We do NOT check whether you copy your solution from the problem solutions or not.
- 9 Homeworks for each of 9 chapters.

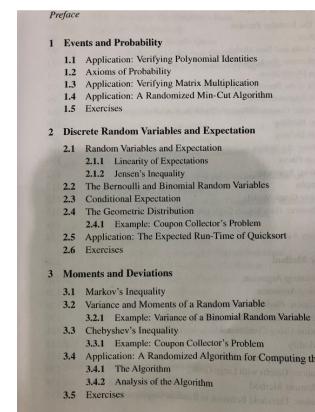
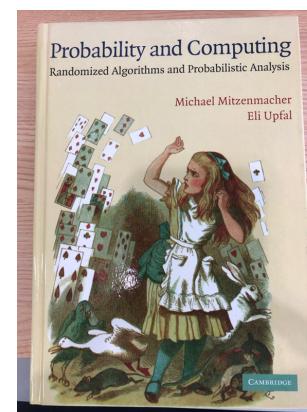
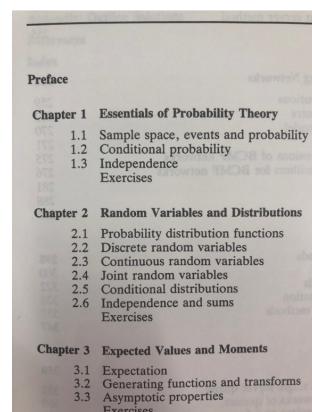
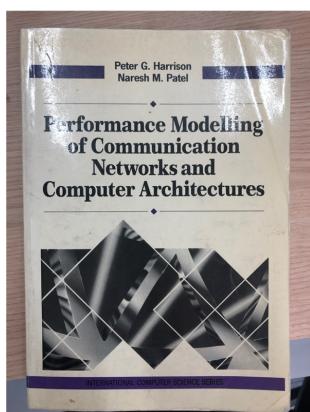
- Read **ALL** the emails and sms from KLMS.
- OK not to be present in the classroom? Yes
- OK that my homework solutions is same as those in the solutions book? Yes
- Can I ask for a personal meeting to ask questions or get other general advices? Yes.
Send me an email.

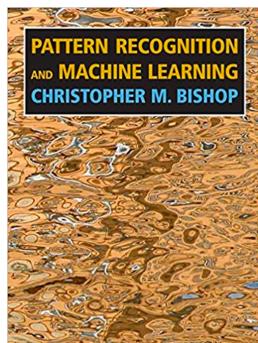
Questions?

- Many things are "probabilistic"
- Assume that you are a designer of the following engineering systems. Good design?
 - a web server
 - a communication device like mobile phones
 - an AI-based image classifier
- From an engineering point of view,
 - System input
 - Algorithms in systems
 - Analysis of systems



Communications	13
Overview of the Book	16
1-6 Bibliographical Notes and References	16
2 Probability and Stochastic Processes	17
2-1 Probability	17
2-1-1 Random Variables, Probability Distributions, and Probability Densities	22
2-1-2 Functions of Random Variables	28
2-1-3 Statistical Averages of Random Variables	33
2-1-4 Some Useful Probability Distributions	37
2-1-5 Upper bounds on the Tail Probability	37
2-1-6 Sum of Random Variables and the Central Limit Theorem	53
2-2 Stochastic Processes	58
2-2-1 Statistical Averages	62
2-2-2 Power Density Spectrum	64
2-2-3 Response of a Linear Time-Invariant System to a Random Input Signal	68
2-2-4 Sampling Theorem for Band-Limited Stochastic Processes	72
2-2-5 Discrete-Time Stochastic Signals and Systems	74
2-2-6 Cyclostationary Processes	75
2-3 Bibliographical Notes and References	77
Problems	77





Copyrighted Material
xiii

CONTENTS	Copyrighted Material
2 Probability Distributions	
2.1 Binary Variables	67
2.2 Multinomial Variables	71
2.2.1 The Dirichlet distribution	74
2.3 The Gaussian Distribution	76
2.3.1 Conditional Gaussian distributions	85
2.3.2 Marginal Gaussian distributions	88
2.3.3 Bayes' theorem for Gaussian variables	90
2.3.4 Maximum likelihood for the Gaussian	93
2.3.5 Sequential estimation	94
2.3.6 Bayesian inference for the Gaussian	97
2.3.7 Student's t-distribution	102
2.3.8 Periodic variables	105
2.3.9 Mixtures of Gaussians	110
2.4 The Exponential Family	113
2.4.1 Maximum likelihood and sufficient statistics	116
2.4.2 Conjugate priors	117
2.4.3 Nonconjugate priors	117
2.5 Nonparametric Methods	120
2.5.1 Kernel density estimators	122
2.5.2 Nearest-neighbour methods	124
Exercises	127
3 Linear Models for Regression	137
3.1 Linear Function Models	138
3.1.1 Maximum likelihood and least squares	140
3.1.2 Geometry of least squares	143
3.1.3 Sequential learning	143
3.1.4 Regularized least squares	144

- Designer's perspective?
- In the year of 2022, suppose that unfortunately there is no theory of mathematically studying the *uncertainty* of some phenomena, events, etc.
- You have to design such a theory called "probability". How are you going to do it? Where are you going to start?
- You just have other basic mathematical theories such as set theory.
- You need to get used to the *English terms* on probability (e.g., sample space = 표본공간, probability density function = 확률밀도함수).
- We will take this exciting journey from the next lecture!

These days, every area in CS and EE is directly or indirectly related to machine learning!

August 22, 2022 17 / 19

August 22, 2022 18 / 19

Questions?



August 22, 2022 19 / 19