

## Lecture 0: Introduction

Yi, Yung (이용)

EE210: Probability and Introductory Random Processes  
KAIST EE

August 25, 2021

August 25, 2021 1 / 21

## Outline

- Course logistics
- Why this course?

August 25, 2021 2 / 21

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

## How to Run This Course

- Basically, **Non-real-time** online class, but with a little bit of real-time zoom classes (if necessary)
- All lecture videos have already been pre-recorded. Now available in **YouTube**.
  - No class attendance check
  - You can watch the videos **anytime** and **anywhere**.
  - You can adjust the speed of studying the materials according to your schedule, as long as you submit the homeworks until the announced deadlines and you show up at the right time for the exams.
- Sometimes, we will open **real-time zoom** classes (maybe biweekly)
  - To answer students' questions
  - To give important announcements
  - etc

# Watching Lecture Videos

- 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](#).



Short Bio: Yung Yi received his B.S. and the M.S. in the School of Computer Science and Engineering from Seoul National University in 1997 and 1999, respectively, and his Ph.D. in the Department of Electrical and Computer Engineering at the University of Texas at Austin in 2006. From 2006 to 2008, he was a post-doctoral research associate in the Department of Electrical Engineering at KAIST, South Korea. His current research interests include machine learning, design and analysis of wired/wireless networking systems. He was the recipient of two best paper awards at SECON 2013 and ACM MobiHoc 2013. He was the co-recipient of IEEE William R. Bennett Award, 2016.

**LANADA (Laboratory of Network Architecture, Design, and Analysis)**

LANADA is a research group which I currently lead. Currently, we do not hire new graduate students.

**Students advised (PHD)**

1. Jimung Lee, 2012, Postdoc at U. of Colorado
2. Jihyeong Lee, 2014, Sony Ericsson, Sweden
3. Joohyun Lee, 2014, Hanyang Univ.
4. Hanjin Park, 2015, National Security Research Institute
5. Donghyun Kim, 2016, Naver
6. Sochwan Lee, 2016, ETRI
7. Jihyeong Lee, 2016, SK Telecom
8. Hyeyoung Jeon, 2016, Donguk Univ.
9. Jungseok Oh, 2017, POSTECH
10. Hyojeong Lee, 2017, Samsung

**Education**

- Ph.D. Dept. of Electrical and Computer Engineering, University of Texas at Austin, 2006 - Current
- M.S. Dept. of Computer Science and Engineering, Seoul National University, 1999
- B.S. Dept. of Computer Science and Engineering, Seoul National University, 1997

**Position**

- KAIST Chair Professor (KAIST 차장학자(校長)) Dept. of Electrical Engineering, KAIST, 2007 - Current
- Full Professor, Dept. of Electrical Engineering, KAIST, 2018.2 - Current
- Associate Professor, Dept. of Electrical Engineering, KAIST, 2011.8 - 2018.2
- Assistant Professor, Dept. of Electrical Engineering, KAIST, 2008.8 - 2011.8
- Postdoctoral Research Associate, Dept. of Electrical Engineering Princeton University, 2006.8 - 2008.8

**Courses**

- Probability and Introductory Random Process (video included), Undergraduate
- Data Structures for Electrical Engineers, Undergraduate
- Mathematics for Machine Learning, Undergraduate
- Computer Network, Undergraduate
- Complex Network Analysis: Eodynamics and Rumours (video included), Graduate

**Contact**  
291 Daehak-  
Electrical En  
N1 Building,  
Daejon, Sou  
Prov., Sou  
Fax: +82 42  
Email: iestha  
edu  
Office Hou

**Memor:**  
  
2020 Spring

August 25, 2021 5 / 21

# Questions, Real-time Zoom Session, and Office Hours

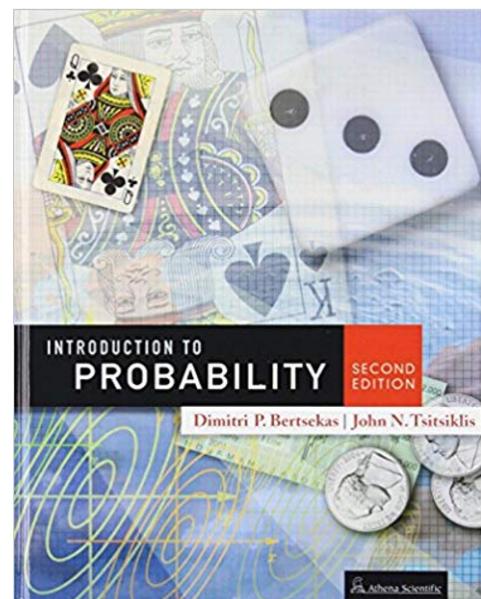
- Questions on the course contents
  - Upload them in the [Q&A board in KLMS](#).
  - Your question will also be very helpful to other classmates
  - Answers to your questions will be given at the [board](#) (if simple), or via separate [lecture videos](#) or a [real-time zoom session](#).
- Real-time Zoom Session
  - Open when necessary and it will be recorded so as to be accessible throughout this semester.
  - The zoom link information will be given in advance at the corresponding week.
- Personal Office Hours
  - Will arrange by an [individual request](#).
  - Send an email to [yiyung@kaist.edu](mailto:yiyung@kaist.edu) for appointment.
  - Questions on the course and other any types of advices that may help you

August 25, 2021 6 / 21

- Lecture videos and slides:  
<https://yung-web.github.io/home/courses/probability.html>
- All other contents: KLMS, <http://klms.kaist.ac.kr/>
  - To ask questions about everything
  - To check your score on each homework/exam
  - To see all the announcements about the class
  - ...
- **Important: Please regularly check!**
  - Emails
  - SMS
  - KLMS announcements

## 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=>



1. Probabilistic model (1/2 week) (08/31)
2. Conditioning and Independence (1/2 week) (09/02)
3. Random Variable, Part I (Discrete Random Variable) (1.5 week) (09/07, 09/09, 09/14)  
**Exam 1 (09/16)** \_\_\_\_\_
4. Random Variable, Part II (Continuous Random Variable) (1.5 week) (09/23, 09/28, 09/30)
5. Random Variable, Part III (Advanced Topic on Random Variable) (1.5 week) (10/05, 10/07, 10/12)  
**Exam 2 (10/14)** \_\_\_\_\_
6. Limit of Scaled Sum of Random Variables: Central Limit Theorem and Weak Law of Large Numbers (1.5 week) (10/19, 10/21, 10/26)
7. Random Process: Bernoulli and Poisson Processes (2 week) (10/28, 11/2, 11/4, 11/9)  
**Exam 3 (11/11)** \_\_\_\_\_
8. Random Process: Markov Chain (2 week) (11/16, 11/18, 11/23, 11/25)
9. Introduction to Statistic Inference (2 week) (11/30, 12/2, 12/7, 12/9)  
**Exam 4 (12/14)** \_\_\_\_\_

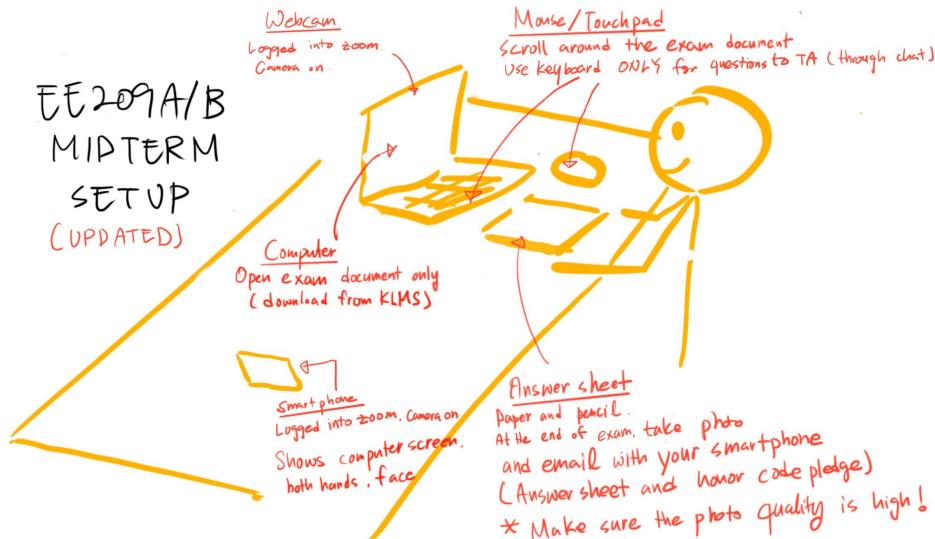
- On-line lectures at MIT and EdX
  - MIT: <http://bit.ly/2PkvYdr>
  - EdX: <http://bit.ly/3pHmZRd>
  - You can find the urls (2006, 2010, 2013) for the MIT lectures based on the same textbook, where there are many useful resources (recitation problems, homework problems, old exam problems, etc)
  - Some of my lecture slides are based on theirs, but my slides are largely modified/reorganized/edited in many places for our purpose.

- 4 Exams
- Schedule Again
  - Exam 1: 09/16, 7:00PM - 10:00PM
  - Exam 2: 10/14, 7:00PM - 10:00PM
  - Exam 3: 11/11, 7:00PM - 10:00PM
  - Exam 4: 12/14, 7:00PM - 10:00PM
  - Check your calendar and empty your schedule at these times.
- 9 Homeworks for each of 9 chapters.
  - Will take just about 2-3 hours if you understand the course contents very well.
  - Try to finish as soon as possible soon after you watch the lecture videos.

- Homeworks: total 36%,  $36/9 = 4$  points for each homework
- Exams: total 64%,  $64/4 = 16$  points for each exam
- Letter or Pass/Fail
  - You can decide until the date of Exam 2
  - No extension
- Cheating
  - **Zero tolerance** (very serious)
  - Honor code from EE department

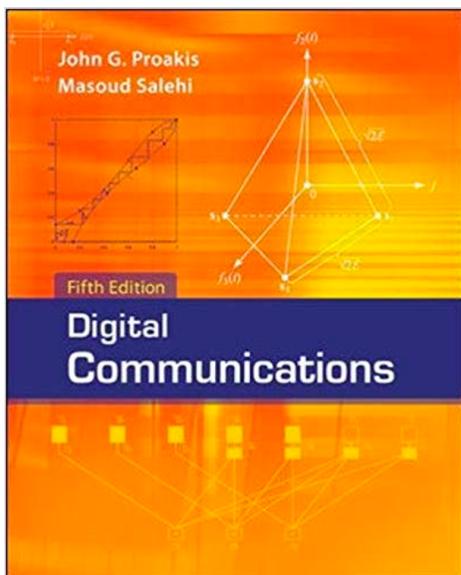
# How to Take Exam

- Will announce more details when you take exams
- Earlier experience from the EE209 class



Questions?

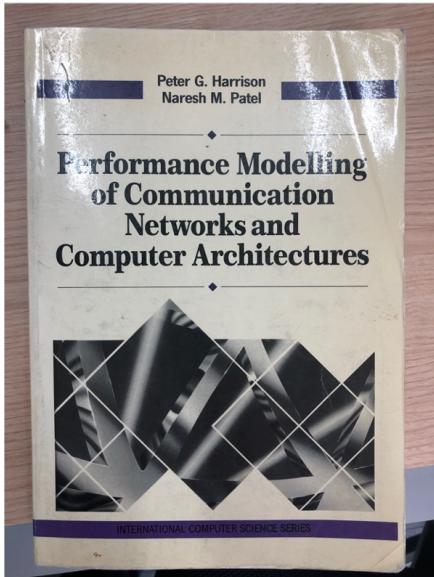
- Many things are "probabilistic"
- Assume that you are a designer of the following engineering systems. Good design?
  - a web server
  - a communication device like mobile phones
  - an AI-based image classifier
- From an engineering point of view,
  - System input
  - Algorithms in systems
  - Analysis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



Communications	13
1-5 Overview of the Book	16
1-6 Bibliographical Notes and References	16
<b>2 Probability and Stochastic Processes</b>	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	53
2-1-6 Sums of Random Variables and the Central Limit Theorem	58
2-2 Stochastic Processes	62
2-2-1 Statistical Averages	64
2-2-2 Power Density Spectrum	67
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

# Textbook: Computer Networking

KAIST EE



Preface

**Chapter 1 Essentials of Probability Theory**

- 1.1 Sample space, events and probability
- 1.2 Conditional probability
- 1.3 Independence

Exercises

**Chapter 2 Random Variables and Distributions**

- 2.1 Probability distribution functions
- 2.2 Discrete random variables
- 2.3 Continuous random variables
- 2.4 Joint random variables
- 2.5 Conditional distributions
- 2.6 Independence and sums

Exercises

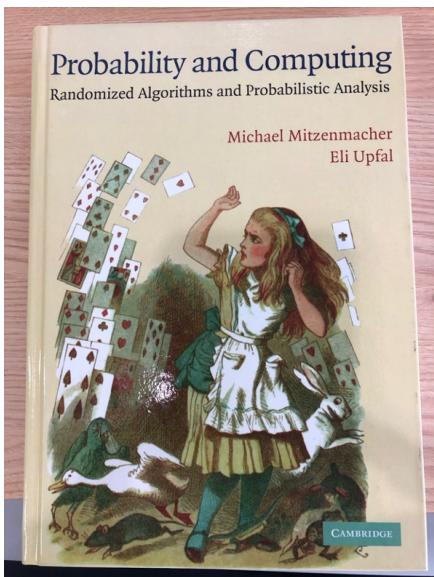
**Chapter 3 Expected Values and Moments**

- 3.1 Expectation
- 3.2 Generating functions and transforms
- 3.3 Asymptotic properties

Exercises

# Textbook: Algorithm and Computing

KAIST EE



Preface

**1 Events and Probability**

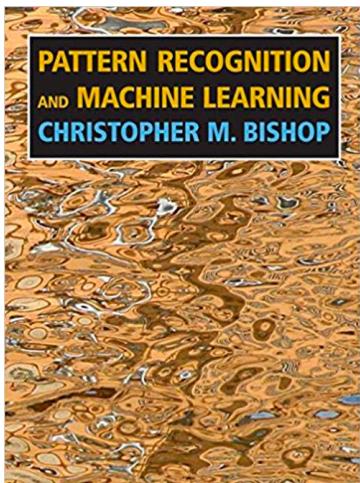
- 1.1 Application: Verifying Polynomial Identities
- 1.2 Axioms of Probability
- 1.3 Application: Verifying Matrix Multiplication
- 1.4 Application: A Randomized Min-Cut Algorithm
- 1.5 Exercises

**2 Discrete Random Variables and Expectation**

- 2.1 Random Variables and Expectation
  - 2.1.1 Linearity of Expectations
  - 2.1.2 Jensen's Inequality
- 2.2 The Bernoulli and Binomial Random Variables
- 2.3 Conditional Expectation
- 2.4 The Geometric Distribution
  - 2.4.1 Example: Coupon Collector's Problem
- 2.5 Application: The Expected Run-Time of Quicksort
- 2.6 Exercises

**3 Moments and Deviations**

- 3.1 Markov's Inequality
- 3.2 Variance and Moments of a Random Variable
  - 3.2.1 Example: Variance of a Binomial Random Variable
- 3.3 Chebyshev's Inequality
  - 3.3.1 Example: Coupon Collector's Problem
- 3.4 Application: A Randomized Algorithm for Computing the 34.1 The Algorithm
- 3.4.2 Analysis of the Algorithm
- 3.5 Exercises



xiv CONTENTS	
Copyrighted Material	xiii
<b>2 Probability Distributions</b>	
2.1 Binary Variables . . . . .	67
2.1.1 The beta distribution . . . . .	68
2.2 Multinomial Variables . . . . .	71
2.2.1 The Dirichlet distribution . . . . .	74
2.3 The Gaussian Distribution . . . . .	76
2.3.1 Conditional Gaussian distributions . . . . .	78
2.3.2 Marginal Gaussian distributions . . . . .	85
2.3.3 Bayes' theorem for Gaussian variables . . . . .	88
2.3.4 Maximum likelihood for the Gaussian . . . . .	90
2.3.5 Sequential estimation . . . . .	93
2.3.6 Bayesian inference for the Gaussian . . . . .	94
2.3.7 Student's t-distribution . . . . .	97
2.3.8 Periodic variables . . . . .	102
2.3.9 Mixtures of Gaussians . . . . .	105
2.4 The Exponential Family . . . . .	110
2.4.1 Maximum likelihood and sufficient statistics . . . . .	113
2.4.2 Conjugate priors . . . . .	116
2.4.3 Noninformative priors . . . . .	117
2.5 Nonparametric Methods . . . . .	120
2.5.1 Kernel density estimators . . . . .	122
2.5.2 Nearest-neighbour methods . . . . .	124
Exercises . . . . .	127
<b>3 Linear Models for Regression</b>	
3.1 Linear Basis Function Models . . . . .	137
3.1.1 Maximum likelihood and least squares . . . . .	138
3.1.2 Geometry of least squares . . . . .	140
3.1.3 Sequential learning . . . . .	143
3.1.4 Regularized least squares . . . . .	143
	144

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

## How to take this course? A designer's perspective

- Designer's perspective?
- In the year of 2021, 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!

Questions?



@imagelife.xyz