Stat 230 Introduction to Probability

Winter 2024

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University of Waterloo

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Contents

Chapter 1

Information of the course

The purpose of this page is to hold some of the additional materials provided by myself. Students should consult UW Learn system.

1.1 Course description

This course provides an introduction to probability models including sample spaces, mutually exclusive and independent events, conditional probability and Bayes' Theorem. The named distributions (Discrete Uniform, Hypergeometric, Binomial, Negative Binomial, Geometric, Poisson, Continuous Uniform, Exponential, Normal (Gaussian), and Multinomial) are used to model real phenomena. Discrete and continuous univariate random variables and their distributions are discussed. Joint probability functions, marginal probability functions, and conditional probability functions of two or more discrete random variables and functions of random variables are also discussed. Students learn how to calculate and interpret means, variances and covariances particularly for the named distributions. The Central Limit Theorem is used to approximate probabilities.

1.1.1 Instructor

Chi-Kuang Yeh, I am a postdoc at the *Department of Statistics and Actuarial Science.*

- Office: M3–3102 Desk 10, but I hold office hour at M3 - 2101 Desk 1, 9:30 – 10:30 on Tuesday.
- Email: chi-kuang.yeh@uwaterloo.ca

1.1.2 Course Coordinator

Dr. Erik Hintz.

- Office: M3–2106
- Email: erik.hintz@uuwaterloo.ca

1.1.3   Logistic Issue

Contact Divya Lala

- Email: divya.lala@uwaterloo.ca or the undergrad advising email sasugr adadv@uwaterloo.ca.

1.1.4   EXAM and Tutorial assessment Date

Midterm

☒ Midterm 1: February 08, 2024 16:30–17:50 (Coverage: Ch. 1 – 5.1)
☒ Midterm 2: March 14, 2024 16:30–17:50 (Coverage: Ch. 1–5, 7-8, up to Sec. 8.3)

Final

☐ Tuesday April 16, 2024 19:30 – 22:00. Location: DC 1350 and DC 1351

Tutorial assessment

☒ Tutorial quiz 1: January 26, 2024 (Coverage: Ch. 1–3)
☒ Tutorial test 1: February 02, 2024 (Coverage: Ch. 1–4)
☒ Tutorial quiz 2: March 01, 2024 (Coverage: Ch. 1-4, and Ch. 7, up to Sec. 7.3)
☒ Tutorial test 2: March 08, 2024 (Coverage: Ch. 1-5, 7-8 up to Sec. 8.1)
☒ Tutorial quiz 3: March 22, 2024 (Coverage: Up to Sec. 9.1, exclude the independence)
☐ Tutorial test 3: April 05, 2024

1.2   Chapters and associated Lectures

Those chapters are based on the lecture notes. The lecture covered is based on *Section 002*. This part will be updated frequently.

Chapter	Lecture Covered
1. Introduction to Probability	L1
2. Mathematical Probability Models	L2–3
3. Probability and Counting Techniques	L3–6
4. Probability rules and Conditional Probability	6–9
5. Discrete Random Variable	L10 –16
6. Computational Methods and the Statistical Software R	In tutorial (not testable)

Chapter	Lecture Covered
7. Expected Value and Variance	L16 –20
8. Continuous Random Variable	L20 – 27
9. Multivariate Distributions	L27 –
10. TBA	TBA

Chapter 2

Lecture 1, January 08, 2024

In this lecture, we went over

1. Course syllabus and rules
2. Chapter 1 – Basic definition of probability. We also saw the potential ambiguities when defining probabilities.

Definition 2.1 (Classical Definition of probability)**.** The **classical** definition: The probability of some event is

$$\frac{\text{number of ways the event can occur}}{\text{the total number of possible outcomes}},$$

provided all outcomes are *equally likely.*

Definition 2.2 (Relative Frequency Definition of of probability)**.** The **relative frequency** definition: The probability of an event is the (limiting) proportion (or fraction) of times the event occurs in a very long series of repetitions of an experiment.

Definition 2.3 (Subjective Definition of Probability)**.** The **subjective** definition: The probability of an event is a measure of how sure the person making the statement is that the event will happen.

Problem: Each of the above definitions has pitfall:

- Classical: We may not be able to know the total number of possible outcomes, or it may be uncountable

- Relative frequency: We need "repetition", which is often expensive and may not be possible.
- Subjective: We want the probability to be consistent across different people, and and be rigorously defined.