



About this Course

Welcome to the course notes for **STAT 414: Introduction to Probability Theory**. These notes are designed and developed by Penn State's [Department of Statistics](#) and offered as open educational resources. These notes are free to use under Creative Commons license [CC BY-NC 4.0](#).

This course is part of the Online [Master of Applied Statistics program](#) offered by Penn State's World Campus.

Currently enrolled?

If you are a current student in this course, please see [Canvas](#) for your syllabus, assignments, lesson videos and communication from your instructor.

How to enroll?

If you would like to enroll and experience the entire course for credit please see '[How to enroll in a course](#)' on the World Campus website.

Course Overview

As the title of Stat 414 suggests, we will be studying the theory of probability, probability, and more probability throughout the course. Here's a (brief!) overview of what we'll do in the course:

Section 1

In [Section 1](#), one of our primary focuses will be to develop an understanding of the various ways in which we can assign a probability to some chance event. We'll also learn the **fundamental properties of probability**, investigate how probability behaves, and learn how to calculate the probability of a new chance event.

Section 2

In [Section 2](#), we'll explore **discrete random variables** and **discrete probability distributions**. The basic idea is that when certain conditions are met, we can derive formulas for calculating the probability of an event. Then, instead of returning to the

Lesson

- Welcome to STAT 414!
- ▶ Section 1: Introduction to Probability
- ▶ Section 2: Discrete Distributions
- ▶ Section 3: Continuous Distributions
- ▶ Section 4: Bivariate Distributions
- ▶ Section 5: Distributions of Functions of Random Variables



basic probability rules we learned in Section 1 to calculate the probability of an event, we can use the new formulas we derived, provided that the certain conditions are met.

Section 3

In [Section 3](#), as the title suggests, we will investigate probability distributions of **continuous random variables**, that is, random variables whose possible outcomes fall on an infinite interval. It's in this section that you'll want to make sure your calculus skills of integration and differentiation are sufficient before tackling many of the problems you'll encounter.

Section 4

In [Section 4](#), we'll extend many of the definitions and concepts that we learned in Sections 2 and 3 to the case in which we have **two random variables**. More specifically, we will:

1. extend the definition of a probability distribution of one random variable to the **joint probability distribution** of two random variables,
2. learn how to use the **correlation coefficient** as a way of quantifying the extent to which two random variables are linearly related,
3. extend the definition of the conditional probability of events in order to find the **conditional probability distribution** of one random variable given that another that has occurred, and
4. investigate a particular joint probability distribution, namely the **bivariate normal distribution**.

Section 5

Finally, in [Section 5](#), as the name of this section suggests, we will spend some time learning how to find the probability distribution of functions of random variables. For example, we might know the probability density function of \mathbf{X} , but want to know instead the probability density function of \mathbf{X}^2 . We'll learn several different techniques for finding the distribution of functions of random variables, including the **distribution function technique**, the **change-of-variable technique** and the **moment-generating function technique**. The more important functions of random variables that we'll explore will be those involving random variables that are independent and identically distributed.