DATA 140

Probability for Data Science

Fall 2025

WEEK 13 STUDY GUIDE

The Big Picture

We move towards one of the most important prediction models. We write familiar facts about expectation and covariance in matrix notation, and use them to study the most important joint distribution in data science.

- We take a closer look at the decomposition of variance by conditioning, and study a variety of examples.
- Linear algebra helps us express properties of sequences of random variables. Expectation and variance are replaced by mean vectors and covariance matrices.
- The multivariate normal distribution has a few equivalent definitions, chief among which is that multivariate normal variables can be represented as a linear transformation of i.i.d. standard normals. Linear combinations of multivariate normal random variables are normal; multiple linear combinations are multivariate normal; and pairwise uncorrelated multivariate normal variables are independent.

Week At a Glance

Mon 11/17	Tue 11/18	Wed 11/19	Thu 11/20	Fri 11/21
	Lecture	Sections	Lecture	Mega sections
HW 12 Due HW 13 (Due 5PM Mon 11/24)				HW 13 party 2PM to 5PM
Lab 7B Due Lab 8 (Due 5PM Mon 11/24)			Lab 8 Party 9 AM to 12 PM	
Skim Section 22.4	Work through Section 22.4	Skim Sections 23.1, 23.2	Work through Sections 23.1, 23.2	Work through Chapter 23

Reading, Practice, and Class Meetings

Book	Topic	Lectures: Professor	Sections	Optional Additional Practice
Ch 22	**Variance by Conditioning** - 22.3 decomposes variance into two pieces, by conditioning - 22.4 is a series of examples of varied uses of the method of 22.3	Tuesday 11/18 - Variance by conditioning - Examples, including a look back at Section 9.2	Wednesday 11/19 - Ch 22 Ex 2, 4 - One question from Midterm 2.	None; focus on the homework
Ch 23	**Multivariate Normal Vectors** - 23.1 derives the mean vector and covariance matrix of a linear transformation of a random vector; covariance matrices are positive semidefinite - 23.2 defines the multivariate normal as a linear transformation of iid standard normals, and covers the resulting properties; in particular, normal marginals don't imply jointly multivariate normal - 23.3 examines the multivariate normal joint density - 23.4 shows that for multivariate normal variables, being pairwise uncorrelated is equivalent to independence	Thursday 11/20 - Random vectors and linear transformations - Multivariate normal and properties	Friday 11/21 - Ch 23 Ex 1, 2, 3 - One question from Midterm 2.	None; focus on the homework