

# PROB 140

Spring 2021



Probability for Data Science

## WEEK 13 STUDY GUIDE

### The Big Picture

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

- 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 4/19  | Tue 4/20                        | Wed 4/21                          | Thu 4/22             | Fri 4/23                             |
|---|---------------------------------|-----------------------------------|----------------------|--------------------------------------|
|   | Instructor's Session            |                                   | Instructor's Session |                                      |
|   |                                 | GSI's Sessions                    |                      | GSI's Sessions                       |
| Checkpoint Week 13<br>(Due Wed 4/21)                        |                                 | <b>Checkpoint Week 13<br/>Due</b> |                      |                                      |
| HW 10 Party 7PM<br><b>HW 10 Due</b><br>HW 11 (Due Mon 4/26) |                                 |                                   |                      |                                      |
| <b>Lab 6B Due</b><br>Lab 7 (Due Mon 4/26)                   |                                 |                                   |                      | Lab 7 Party 5PM                      |
| Skim Sections 23.1  | Read Section 23.1,<br>skim 23.2 | Skim Sections 23.2 to<br>23.4     | Read Chapter 23      | Work some<br>exercises from Ch<br>23 |

**Note: The lab is due in one week**, not two, because it's a workout in the construction of the multivariate normal. The earlier you do it, the easier it will be for you to understand what's happening in the chapter.

## Reading, Practice, and Live Sessions

| Sections | Topic  | Live Sessions: Prof. A.  | Live Sessions: GSIs  | Recommended Practice   |
|----------|--|--|--|--|
| Ch 23    | <b>Multivariate Normal Vectors</b> <ul style="list-style-type: none"> <li>- 23.1 derives the mean vector and covariance matrix of a linear transformation of a random vector; covariance matrices are positive semidefinite</li> <li>- 23.2 defines the multivariate normal distribution in three equivalent ways; the two-dimensional case is called bivariate normal</li> <li>- 23.3 is about linear combinations of multivariate normals: they are also multivariate normal, and marginals are normal. But normal marginals don't imply multivariate normal joint distribution</li> <li>- 23.4 shows that for multivariate normal variables, being pairwise uncorrelated is equivalent to independence</li> </ul> | <p><b>Tuesday 4/20</b></p> <ul style="list-style-type: none"> <li>- Random vectors and linear transformations</li> <li>- Multivariate normal and properties</li> </ul> <p><b>Checkpoint is based on Section 23.1</b></p> <p><b>Thursday 4/22</b></p> <ul style="list-style-type: none"> <li>- Multivariate normal and properties, continued</li> </ul> | <p><b>Wednesday 4/21</b></p> <ul style="list-style-type: none"> <li>- Ch 23 Ex 2, 3</li> </ul> <p><b>Friday 4/23</b></p> <ul style="list-style-type: none"> <li>- Ch 23 Ex 5, 6</li> </ul> | <p><b>Ch 23</b></p> <ul style="list-style-type: none"> <li>- Any exercise not covered in section or assignments</li> </ul> |