

# PROB 140 Fall 2021

## 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 11/15                  | Tue 11/16                                  | Wed 11/17                       | Thu 11/18                  | Fri 11/19                      |
|----------------------------|--|---------------------------------|----------------------------|--------------------------------|
|                            | Instructor's Session                       |                                 | Instructor's Session       |                                |
|                            |  | GSI's Sessions<br><b>Quiz 3</b> |                            | GSI's Sessions                 |
| HW 12 Party 12-2PM         | <b>HW 12 Due</b><br>HW 13 (Due Tue 11/23)  |                                 |                            |                                |
|                            | <b>Lab 7B Due</b><br>Lab 8 (Due Tue 11/23) |                                 |                            | Lab 8 Party 3-6PM              |
| Skim Sections 23.1 to 23.2 | Read Section 23.1 and 23.2                 | Skim Sections 23.3 to 23.4      | Read Sections 23.3 to 23.4 | Work some exercises from Ch 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:<br>Prof. Sahai  | Live Sessions: GSIs   | Recommended<br>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 11/16</b></p> <ul style="list-style-type: none"> <li>- Random vectors and linear transformations</li> <li>- Multivariate normal and properties</li> </ul> <p><b>Thursday 11/18</b></p> <ul style="list-style-type: none"> <li>- Multivariate normal and properties, continued</li> </ul> | <p><b>Wednesday 11/17</b></p> <ul style="list-style-type: none"> <li>- Ch 23 Ex 3</li> </ul> <p><b>Friday 11/19</b></p> <ul style="list-style-type: none"> <li>- Ch 23 Ex 2, 5</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> |