

*Introduction to Mathematical Statistics* 8th Edition, Hogg,  
McKean, Craig (Pearson, 2019)  
Study Guide for Chapter 2, Multivariate Distributions

The following is a *brief* list of topics covered in Chapter 2 of Hogg, McKean, and Craig's *Introduction to Mathematical Statistics*, 8th edition. This list is not meant to be comprehensive, but only gives a list of several important topics.

**2.1. Distributions of Two Random Variables.**

Random vector, space of  $(X_1, X_2)$ , event, joint cumulative distribution function, continuous random vector, concerns over the collection of events ( $\sigma$ -fields and Borel sets), discrete random vector, joint probability mass function, joint probability density function, support, marginal distribution, marginal probability mass function, marginal probability density function, expectation, linearity of expectation (Theorem 2.1.1), moment generating function, expected value of a random vector, evaluation of double integrals.

**2.2. Transformations: Bivariate Random Variables.**

Examples and more evaluation of double integrals, substitution in double integrals and the Jacobian, Laplace distribution (Example 2.2.7).

**2.3. Conditional Distributions and Expectations.**

Conditional probability, conditional probability mass function, conditional probability density function, conditional expectation, conditional mean, conditional variance, example of conditioning on a probability 0 event (Example 2.3.1), properties of expectation and variance (Theore, 2.3.1).

**2.4. Independent Random Variables.**

Independent and dependent random variables, properties of independent random variables (Theorems 2.4.1, 2.4.2, and 2.4.3), independent random variables and moment generating functions (Theorem 2.4.5).

**2.5. The Correlation Coefficient.**

Covariance, correlation coefficient, the range of the correlation coefficient (Theorem 2.5.1), covariance of independent random variables (Theorem 2.5.2), linear conditional expectation (Theorem 2.5.3), examples.

**2.6. Extension to Several Random Variables.**

Random vector, space, cumulative density function, expected value, marginal probability density function, joint conditional probability density function,

conditional expectation, mutually independent random variables, moment generating function, moment generating function as given by Theorem 2.6.1, pairwise independence does not imply mutually independent (the example of Bernstein), independent and identically distributed (“idd”), moment generating function of idd random variables (Corollary 2.6.1), expectation, variance-covariance matrix, positive semi-definite matrix and Corollary 2.6.A.

### **2.7. Transformations for Several Random Variables.**

Jacobian, evaluating multiple integrals using transformations and Jacobians, examples.

### **2.8. Linear Combinations of Random Variables.**

Expectation of a linear combination (Theorem 2.8.1), covariance of linear combinations (Theorem 2.8.2), variance of a linear combination (Corollaries 2.8.1 and 2.8.2), random sample, sample mean, sample variance, expectation and variance of sample mean and sample variance (Theorem 2.8.A).