

MAT 1034 INTRODUCTION TO PROBABILITY

Chapter 4: Multivariate Probability Distribution

1. Joint Probability Distributions

Our study of random variables and their probability distributions in the preceding chapters is restricted to one-dimensional sample spaces, where we recorded outcomes of an experiment as values assumed by a single random variable. There will be situations, however, where we may find it desirable to record the simultaneous outcomes of several variables. For example:

1. We might measure the amount of precipitate P and volume V of gas released from a controlled chemical experiment, giving rise to a two-dimensional sample space consisting of the outcomes (p, v) .
2. We might be interested in the hardness H and tensile strength T of cold-drawn copper, resulting in the outcomes (h, t) .
3. In a study to determine the likelihood of success in college based on high school data, we might use a three-dimensional sample space and record for each individual his or her aptitude test score, high school class rank, and grade-point average at the end of freshman year in college.

If X and Y are two discrete random variables, the probability distribution for their simultaneous occurrence can be represented by a function with values $f(x, y)$ for any pair of values (x, y) within the range of the random variables X and Y . This function is referred to as the joint probability distribution of X and Y .

Hence, in the discrete case,

$$f(x, y) = P(X = x, Y = y)$$

that is, the values $f(x, y)$ give the probability that outcomes x and y occur at the same time.

Definition 1.1

The function $f(x, y)$ is a joint probability distribution or probability mass function of the discrete random variables X and Y if

1. $f(x, y) \geq 0$ for all (x, y)
2. $\sum_x \sum_y f(x, y) = 1$
3. $P(X = x, Y = y) = f(x, y)$

For any region A in the xy plane, $P[(X, Y) \in A] = \sum_x \sum_y f(x, y)$

Chapter 4 Multivariate Probability And Statistics

BM King

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