CHAPTER OVERVIEW

5: Special Distributions

In this chapter, we study several general families of probability distributions and a number of special parametric families of distributions. Unlike the other expository chapters in this text, the sections are not linearly ordered and so this chapter serves primarily as a reference. You may want to study these topics as the need arises.

First, we need to discuss what makes a probability distribution *special* in the first place. In some cases, a distribution may be important because it is connected with other special distributions in interesting ways (via transformations, limits, conditioning, etc.). In some cases, a parametric family may be important because it can be used to model a wide variety of random phenomena. This may be the case because of fundamental underlying principles, or simply because the family has a rich collection of probability density functions with a small number of parameters (usually 3 or less). As a general philosophical principle, we try to model a random process with as few parameters as possible; this is sometimes referred to as the principle of *parsimony of parameters*. In turn, this is a special case of *Ockham's razor*, named in honor of William of Ockham, the principle that states that one should use the simplest model that adequately describes a given phenomenon. Parsimony is important because often the parameters are not known and must be estimated.

In many cases, a special parametric family of distributions will have one or more distinguished *standard members*, corresponding to specified values of some of the parameters. Usually the standard distributions will be mathematically simplest, and often other members of the family can be constructed from the standard distributions by simple transformations on the underlying standard random variable.

An incredible variety of special distributions have been studied over the years, and new ones are constantly being added to the literature. To truly deserve the adjective *special*, a distribution should have a certain level of mathematical elegance and economy, and should arise in interesting and diverse applications.
