Fixed and Random Effects

Let's take a closer look at the two types of effects in a mixed model: fixed and random. To determine whether an effect is fixed or random, you look at the levels of that factor that are included in the study. Do those levels represent the entire population that you want to study, or only a sample of the population?

An effect is fixed when the levels included in the study constitute the entire population in which you are interested. An effect is random when the levels included in the study represent only a sample from that population. How the researcher selects the levels of an effect depends on the role of that factor in the study. Let's look at the role of fixed effects and random effects.

Fixed effects are factors whose levels are selected deliberately to evaluate the differences between those levels. All levels of interest are in the data set. The researcher is interested in comparing the effects of the factors on the response variable only for the levels that are included in the study. For example, in a drug study, you want to compare the effect of the three drugs A, B, and C—and only those three drugs. Any conclusions that you draw from the study will apply only to those three drugs. Your data set contains the variable **Drug**, which has the levels A, B, and C. **Drug** is a fixed effect. Other examples of fixed effects that represent all of the levels of interest for the study might include **Gender**, **Treatment**, **Method**, and **Brand**.

Now let's look at how random effects are used in a study. A random factor has a large number of levels and the researcher or data analyst selects a subset of the levels to be included in the study. This subset of levels represents a sample (although often an imperfect sample) from a population that has a probability distribution. The inference about the fixed effects from the data analysis applies to all population levels of the random effects and not only to the subset of levels included in the study. The parameters of interest for random effects are typically the variance components.

Let's see what role a random effect has in the drug study discussed earlier. Remember that the goal was to compare the effect of three drugs. **Drug** is a fixed effect with the levels A, B, and C. Suppose you want to make an inference for the drug effects across the population of clinics in a region based on a random sample of four clinics. In the study, **Clinic** is a random effect that contains a random sample of four clinics from a population of clinics. **Clinic** can also be referred to as a blocking effect. This is a mixed model because it contains both a fixed effect and a random effect. A model that contains only fixed effects is called a fixed effects model. And a model that contains only random effects is called a random effects model. For additional details about fixed and random effects, click the Information button.

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