Mixed Models: Examples

Let's look at two examples of mixed models. The first example is an experiment to test the strength of metals used for bonding. The second example is a study of gains in test scores by school.

In the first example of a mixed model, an engineer wants to test the strength of three metals (copper, iron, and nickel) that are used as bonding agents. To do this, the engineer performs a strength test. From a population of ingots made of composition material, the engineer randomly selects seven ingots. She then takes a sample of material from each ingot, cuts each sample, and bonds each sample using one of the three metals. Finally, she records the amount of pressure that is required to break the bond. This mixed model design has two effects: **Metal**, the treatment effect, and **Ingots**, a blocking effect. The engineer wants to make an inference about only the three bonding metals used in the study, so **Metal** is a fixed effect. The seven ingots used in the study are randomly selected from a population of ingots. The engineer wants to make an inference about metals over the entire population of ingots. Therefore, **Ingots** is a random effect.

In the second example of a mixed model, a school district recorded the gains in scores on a standardized test for 1,515 fourth-grade students in all schools in the district. Gain is defined as the score at the end of the year minus the score at the beginning of the year. The school district also recorded each student's school, gender, and ethnicity, as well as the identification number of the student's teacher. For this observational study, the school district's primary objective was to evaluate and compare the schools on the gain scores. A secondary objective was to assess the effects of gender and ethnicity on the gain scores. The following effects are used in this study: **School** is a fixed effect because all of the schools in the district are included in the study, and only those schools are of interest. For the same reason, **Ethnicity** and **Gender** are fixed effects. **Teacher** is a random effect because the teachers represent a sample of the population of teachers who could teach at the schools.

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