

Statistics 5301 — Final Exam
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This is an open book, open notes exam.

1) For each of the following situations, briefly describe an appropriate experimental design.

a) Girls and boys have approximately equal achievement in math until grade seven, when girls begin to lose ground relative to boys. One theory for this is that there are social causes, and girls in all female classes would achieve as well as boys. A school district would like to compare girls' math achievement in mixed gender classes and all girls classes. The comparison will be limited to the seventh and eighth grades, and the response will be the score on an end-of-year exam. We expect achievement differences between the grades. Logistics constrain us to at most six classes in each grade. Six teachers have agreed to participate in the study. The teachers can teach all grade/gender combinations. We expect some teacher to teacher variability.

b) There has been some controversy at the legislature lately over how much consumption of alcohol is required to raise the blood alcohol level to the new proposed .08% drunk driving standard. The principle issue is whether two glasses of wine would put someone over the legal limit. The factors that are believed to affect the alcohol level are amount of alcohol consumed, body weight, and time since alcohol consumption. We have 100 volunteers, and we would like to see what their blood alcohol level will be 1 hour after consuming alcohol. Subjects will drink either 1, 2, 3, or 4 glasses of white wine in a 30 minute period. Alcohol level will be measured using a "Breathalyzer".

c) You are a computer engineer working in marketing. A client will make a large purchase if you can configure a workstation that has good performance on her “benchmark” program and reasonable cost. You have seven design factors under your control: cpu speed, ram size, cache size, cache speed, bus speed, disk speed, and disk cache size; each of these has two levels. The high levels of each factor might improve performance; high levels certainly increase costs. You can approximate the response of each configuration on her benchmark via simulation, but each simulation takes about 6 hours. You have 2 days for study; after that time you must present your configurations (with their simulated benchmark scores).

2) For each of the following, describe the experimental design used and give a skeleton anova (sources and df only).

a) Food products companies would like to have wheat flours that will yield strong doughs (when mixed with water) after short mixing times. One factor that may influence the strength of doughs is the size of the starch granules in the flour. We have obtained 12 flours. Six are large starch granule flours, and the six are small starch granule flours. The doughs are prepared by mixing fixed amounts of flour and water, and we measure the strength of each dough (at its peak resistance to mixing). We also measure the initial moisture content of the flour, since that affects the total amount of water in the dough and may affect the strength of the dough.

b) Researchers have recently reported the results of an experiment on human pheromones. Underarm perspiration was collected on gauze pads from several volunteer women. The pads were cut into pieces and frozen. Type A pads were collected early in the donor's menstrual cycle, and type B pads were collected in a later phase of the donor's menstrual cycle. Later 20 volunteer women were divided into two groups of 10. All 20 women had a thawed gauze piece rubbed on their upper lip each day for four months. The 10 women in the first group had two months of type A, followed by two months of type B. The other 10 women had the opposite pattern (B then A). The response measured was the average length of the menstrual cycle (in days) during each treatment.

c) We have a camera that can use different lenses and different brands of film. We will be shooting indoor portrait type pictures, and we wish to know which lens and which type of film to use. We compare three lenses, two brands of film, and two speeds of film. We use two rolls of each brand/speed combination of film (total of 8 rolls). We choose one of the 8 rolls randomly, and take three pictures of a standard scene. These three pictures are taken with the three lenses in random order. The film is then unloaded from the camera. This is repeated for the other rolls. The 24 exposed frames are developed and judged (blindly). The response is perceived picture quality.

3) There has been considerable controversy lately over deformed frogs. Consider the following experiment. Eight lakes are chosen; four of these are randomly selected from lakes where deformed frogs have been observed, the other four are from lakes where no deformed frogs have been observed. From each lake, one breeding pair of frogs is chosen. Each pair is bred and 80 eggs are collected from each pair. The 80 eggs from each pair are randomly divided into 8 sets of 10 each. Each set of 10 is then hatched in one of 8 environments. These environments are water from the 8 municipal wells in the region. The response measured is whether or not an egg hatches into a deformed frog. Construct a Hasse diagram for this experiment. What is the error term for the municipal well main effect?

4) Confound a 2^4 factorial into 4 blocks of size 4 using AB and BCD as generators. Give the factor/level combinations that go into each block.