Fifteen scenarios are described below (courtesy of Professor Craig), for which we need to perform the following exercises:

- 1. State the research hypothesis or goal of the experiment.
- 2. Describe the experimental design used (i.e., type of design, blocking and treatment factors, nested and crossed factors, fixed or random effects, outcome variable), or suggest an adequate design using the available resources.
- 3. Describe an analysis plan along with a sketch of ANOVA table (contains sources and degrees of freedom).

Scenarios 4, 5, 7, 8, 9, 10, 12, 13 are left as homework problems due on April 14. The rest will be used in in-class discussions.

- Scenario #1 We wish to discover the effects of food availability on the reproductive success of anole lizards, as measured by the number of new adults appearing after the breeding season. There are twelve very small islands with anole populations available for the study. The islands are man-made and more or less equally spaced along a northsouth line. The treatments will be a manipulation of the food supply on the islands during peak breeding season. There are three treatments: control (leave natural), add supplemental food, and reduced food (set out traps to deplete the population of insects the anoles eat). One potential source of variation is that the lizards are eaten by birds, and there is a wildlife refuge with a large bird population near the northern extreme of the study area. To control for this, we group the islands into the north three, the next three, and so on, and randomize the treatments within these groups.
- Scenario #2 We wish to study the effects of stress and activity on the production of a hormone present in the saliva of children. The high-stress treatment is participation in a play group containing children with whom the subject child is unacquainted; the low-stress treatment is participation in a play group with other children already known to the subject child. The activities are a group activity, where all children play together, and an individual activity, where each child plays separately. Thirty-two children are split at random into two groups of sixteen. The first group is assigned to high stress and the other to low stress. For each child, the order of activity (group or individual) is randomized, and a saliva sample is taken during each activity.
- Scenario #3 We wish to study the effects of air pressure (low or high) and tire type (radial versus all season radial) on gas mileage. We do this by fitting tires of the appropriate type and pressure on a car, driving the car 150 miles around a closed circuit, then changing the tire setting and driving again. We have obtained eight cars for this purpose and can use each car for one day. Unfortunately, we can only do three of the four tire combinations on one day, so we have each factor-level combination missing for two cars.
- Scenario #4 National forests are managed for multiple uses, including wildlife habitat. Suppose that we are managing our multiple-use forest, and we want to know how

snowmobiling and timber harvest method affect timber wolf reproductive success (as measured by number of pups surviving to 1 year of age over a 5-year interval). We may permit or ban snowmobiles; snowmobiles cover a lot of area when present, so we can only change the snowmobile factor over large areas. We have three timber harvest methods, and they are fairly easy to change over small areas. We have six large, widely dispersed forest sections that we may use for the experiment. We choose three sections at random and ban snowmobiles there. The other three sections allow snowmobiles. Each of these sections is divided into three zones, and we randomly assign one of the three harvest methods to each zone within each section. (Note that we do not harvest the entire zone; we merely use that harvest method when we do harvest within the zone.) We observe timber wolf success in each zone.

- Scenario #5 Some aircraft have in-flight deicing systems that are designed to prevent or remove ice buildup from the wings. A manufacturer wishes to compare three different deicing systems. This is done by installing the system on a test aircraft and flying the test aircraft behind a second plane that sprays a fine mist into the path of the test aircraft. The wings are photographed, and the ice buildup is estimated from interpretation of the photographs. They make five test flights for each of the three systems. The amount of buildup is influenced by temperature and humidity at flight altitude. The flights will be made at constant temperature (achieved by slightly varying the altitude); relative humidity cannot be controlled, but will be measured at the time of the flight.
- Scenario #6 A national travel agency is considering new computer hardware and software. There are two hardware setups and three competing software setups. All three software setups will run on both hardware setups, but the different setups have different strengths and weaknesses. Twenty branches of the agency are chosen to take part in an experiment. Ten are high sales volume; ten are low sales volume. Five of the high-sales branches are chosen at random for hardware A; the other five get hardware B. The same is done in the low-sales branches. All three software setups are tried at each branch. One of the three software systems is randomly assigned to each of the first 3 weeks of May (this is done separately at each branch). The measured response for each hardware-software combination is a rating score based on the satisfaction of the sales personnel.
- Scenario #7 We wish to study the effect of drought stress on height growth of red maple seedlings. The factors of interest are the amount of stress and variety of tree. Stress is at two levels: no stress (that is, always well-watered) and drought-stressed after 6 weeks of being well-watered. There are four varieties available, and all individuals within a given variety are clones, that is genetically identical. This will be a greenhouse experiment so that we can control the watering. Plants will be grown in six deep sandboxes. There is space in each sandbox for 36 plants in a 6 by 6 arrangement. However, the plants in the outer row have a dissimilar environment and are used as a guard row, so responses are observed on only the inner 16 plants (in 4 by 4 arrangement). The six sandboxes east

to west. We anticipate considerable differences in light (and perhaps temperature and other related factors) on the north to south axis. No differences are anticipated on the east to west axis. Only one watering level can be given to each sandbox. Variety can be varied within sandbox. The response is measured after 6 months.

- Scenario #8 Metribuzin is an agricultural chemical that may accumulate in soils. To see if the amount retained in the soil depends on the amount applied to the soil, the following experiment was performed. Three different levels of metribuzin were equally and randomly assigned to a total of 24 plots. After one growing season, the amount of metribuzin in the first three cm of soil was measured. The pH of the soil in each plot was also measured as pH may affect the ability of the soil to retain metribuzin.
- Scenario #9 A forest products company conducts a study on twenty sites of 1 hectare each to determine good forestry practice. Their goal is to maximize the production of wood biomass (used for paper) on a given site over 20 years. All sites in the study have been cut recently, and the factors of interest are species to plant (alder or birch) and the thinning regime (thin once at 10 years, or twice at 10 and 15 years). The species is assigned at random to each site. The sites are then split into east-west halves. The thinning regimes are assigned at random to east-west halves independently for each site.
- Scenario #10 We wish to study the acidity of orange juice available at our grocery store. We choose national brands. We then choose 3 days at random (from the next month) for each brand; cartons of brand A will be purchased only on the days for brand A, and similarly for brand B. On a purchase day for brand A, we choose five cartons of brand A orange juice at random from the shelf, and similarly for brand B. Each carton is sampled twice, and the samples are measured for acidity.
- Scenario #11 We wish to determine the number of warblers that will respond to three recorded calls. We will get eighteen counts, nine from each of two forest clearings. We expect variation in the counts from early to mid to late morning, and we expect variation in the counts from early to mid to late in the breeding season. Each recorded call is used three times at each clearing, arranged in such a way that each calls is used once in each phase of the breeding season and once in each morning hour.
- Scenario #12 We wish to study new varieties of corn for disease resistance. We start by taking four varieties (A, B, C, D) and cross them (pollen from type A, B, C, or D fertilizing flowers from type A, B, C, or D), getting sixteen crosses. (This is called a diallel cross experiment, and yes, four of the sixteen crosses are actually pure varieties.) The sixteen crosses produce seed, and we now treat the crosses as varieties for our experiment. We have 48 plots available, 16 plots in each of St. Paul, Crookston, and Waseca. We randomly assign each of the crosses to one of the sixteen plots at each location.
- Scenario #13 A political scientist wishes to study how polling methods affect results. Two candidates (A and B) are seeking endorsement at their party convention. A random

sample of 3600 voters has been taken and divided at random into nine sets of 400. All voters were asked if they support candidate A. However, before the question was asked, they were either told (a) that the poll is funded by candidate A, (b) that the poll is funded by candidate B, or (c) nothing. Due to logistical constraints, all voters in a given set (of 400) were given the same information: the response for a set of 400 is the number supporting candidate A. The three versions of information were randomly assigned to the nine sets.

- Scenario #14 Neurologists use functional Magnetic Resonance Imaging (fMRI) to determine the amount of the brain that is activated (in use) during certain activities. We have twelve right-handed subjects. Each subject will lie on the magnet. On a visual signal, the subject will perform an action (tapping of fingers in a certain order) using either the left or the right hand (depending on the signal). The measured response is the number of pixels on the left side of the brain that are activated. We expect substantial subject to subject variation in the response, and there may be a consistent difference between the first trial and the second trial. Six subjects are chosen at random for the left-right order, and the other six get right-left. We obtain responses for each subject under both right and left-hand tapping.
- Scenario #15 A grocery store chain is experimenting with its weekly advertising, trying to decide among cents-off coupons, regular merchandise sales, and special-purchase merchandise sales. There are two cities about 100 km apart in which the chain operates, and the chain will always run one advertisement in each city on Wednesday, with the offer good for 1 week. The response of interest is total sales in each city, and large city-to-city differences in total sales are expected due to population differences. Furthermore, week-to-week differences are expected. The chain runs the experiment on 12 consecutive weeks, randomizing the assignment of advertising method to each city, subject to the restrictions that each of the three methods is used eight times, four times in each city, and each of the three pairs of methods is used an equal number of times.