**Written Project:** Please return your written work by 1 April 2023 at 11:59pm.

The expectation is students will work in groups of up to 3 people (groups of size 1, 2 or 3 are fine).

There are no "uniquely correct" answers to these questions. Rather you will be graded on a combination of presentation (organization, clarity, etc worth about 1/3 of the mark for the exam), examining competing approaches to the problem with reasons on why you selected your particular approach (about 1/3 of the mark), and on the correctness of your chosen analysis (about 1/3 of the mark).

I would much rather see a well thought out clear response that comes close to solving the problem than a technically brilliant analysis that is poorly organized and hard to follow.

**Effect of humidity on the growth of two varieties of a plant**

There has been much interest upon the effects of humidity upon the growth of two varieties (B52 and Northern Light) of the plant *C. sativa*. In many cases a high humidity level is required to get good growth.

To conduct the experiment, up to 20 mini-greenhouses are available. Each greenhouse can house up to 4 pots and each pot can hold up to two seedlings of the plant. It is not necessary to use all pots within a greenhouse, nor to plant 2 seedlings in each pot, nor to plant the same variety of seedling in each pot. You may assume that each pot is large enough that seedlings within a pot do not interfere with each other regardless if they are the same or different varieties.

You have complete flexibility to design your experiment using any design that you wish under the following constraints:

- Each greenhouse that you use costs $100 for setup regardless of the number of pots or plants in the greenhouse.
- Each pot you use costs $10 to set up (soil and preparation time) regardless if one or two seedlings are planted in a pot.
- Each seedling of each variety costs $1 to procure, initiate, and to plant.
- You have a total budget of $3000.

The purpose of the experiment is to assess if growing these plants in a full scale production in high humidity greenhouses is economically viable. Because of the additional costs of set up for high humidity levels in production, the mean yield under high humidity levels should be at least 10% higher than low humidity to cover costs.

To "collect" your data, you will email (dbingham@sfu.ca) your experimental design to me, and I will email your data to you. Use the email subject: Stat403/603 data. You want to do this sooner than later.

The format for the design should be a .txt-file with columns indicating: greenhouse #, humidity level (High or Low), pot # in the greenhouse, plant variety in the pot and plant variety #2 if there is a second plant in the pot. **You can email AT MOST 2 designs to me** (the first might be a pre-test or pilot design). For example, the first few rows of your .txt-file might look like (I used only 1 plant per pot here):

| greenhouse | humidity | pot | plant 1 | plant 2 |
|---|---|---|---|---|
| 1 | L | 1 | NR | |
| 1 | L | 2 | B52 | |
| 1 | L | 3 | B52 | |
| 1 | L | 4 | NR | |
| 2 | H | 1 | NR | |
| 2 | H | 2 | NR | |
| 2 | H | 3 | B52 | |
| 2 | H | 4 | B52 | |
| . | . | . | . | |
| . | . | . | . | |
| . | . | . | . | |

**Written report:**

The report could be broken into 4 sections:

1. Preamble. Discuss the:
    - Purpose of the study
    - Treatment structure: two factors (humidity and variety), their levels
    - Experimental unit structure: What are the experimental units? Greenhouse? Pot? There is a potential for pseudo-replication both at the plant level, so be careful.
    - Randomization structure: You will randomly assign humidity levels to greenhouses and varieties to pots. Should you random assign pots to the various positions within the greenhouse?
    - Design considerations? A split-plot design is obvious but a CRD could also be run. Why is a split-plot a natural choice?
2. Pre-test

    Do a pre-test to estimate residual variation for a power/sample size study. One such pre-test would involve 6 green houses, 3 at high and 3 at low humidity levels. Within each greenhouse, use 2 pots for NL and 2 pots for B52. In each pot, plant two plants of the same variety.

Don't do a large amount of analysis on the pre-test results - all you basically are doing is proving the equipment and **obtaining estimates of variation**.

Estimate the required sample size to detect the biologically important difference.

3. Full experiment.

   Run the full experiment. Be sure to randomize over greenhouses and positions (i.e., pots) within each greenhouse.

   Produce plots. Are there any outliers? Examine if the raw sample standard deviations are roughly equal in each treatment group. Are the assumptions necessary for an ANOVA satisfied?

   Produce a profile plot. Does it appear that interaction will exist between the two factors?

   Test for and estimate the size of the main effects. See if the detected difference exceeds the biologically important difference.

   Construct a summary plot (it could be the profile plot with se bars added).

4. Conclusions: Make a recommendation about whether or not it appears that

I will read only the first 6 pages of your report (including all figures and tables). Acceptable format is single-sided single-spaced at a minimum of 12-point type and 2.5 cm margins all around. You may attach appendices with the experimental plan and any other information you want to include in appendices that I will only look at the appendices if I don't understand something in the main report. You shouldn't refer to the appendices in the main body of the report.