Your assignment is to perform two projects, as described in this document. For each project, you will first submit a proposal. After I approve your proposal you should collect your data and write your report. I will not evaluate draft reports; I have neither the time nor the inclination to read a report, return comments, and read it again. No exceptions! If you follow the directions given below, there should be no need to submit a draft report.

Each proposal will be worth one point and each report will be worth four points, for a total of 10 points possible. Any credit you earn for a proposal will disappear if you do not subsequently submit a report.

For each project, you may work alone or as a member of a team of three or fewer students. If you work as a team, only one report should be submitted by the team—remember to include the names of all team members on the report. All members of the team will receive the same grade. Neither my expectations for, nor grading of, reports will be influenced by the size of the team.

You may have the same or different teammates on your two projects; you may submit one project alone and the other as a member of a team; or you may conduct both projects by yourself. (Have I missed any possibilities? If so, contact me!)

Each student on a project team—of two or three students—will receive 0.3 points of extra credit. Thus, if you work on a team on both projects you will receive 0.6 points of extra credit. This is real extra credit in the sense that I will set the final grade curve without looking at extra credit. After the curve is set I will look at all persons who are within 0.6 points of the next higher grade. For example, in Fall, 2014, the lower cut-off for an AB was 170.5 points (out of 200 possible, just like this semester). If I had had extra credit in effect in Fall, 2014, I would have checked each student who scored between 169.9 and 170.4 points and determine whether he/she had enough extra credit to cross the threshold for an AB. If not, the grade would remain a B. Note the following:

- Nobody will receive a lower course grade because he/she did not earn extra credit. The curve is set before extra credit is factored into the process. A (small) number of students will receive a higher grade because of extra credit. For the big majority of students, the extra credit will not change the course grade.
Note that 170.5 was the cut-off for an AB in Fall, 2014. Your cut-off might be lower, the same or higher.

I will be grading the proposals and reports; thus, contact me, not your TA, if you have a question about what I want.

Nearly all students have uploaded their proposals and reports into a D2L dropbox. Documents with suffixes of .pdf; .docx; and .jpg have been popular with my students and work well with the following caveat: if you submit a .jpg file, make sure you upload with the proper orientation. (Holding my monitor sideways is no fun!)

Some students have submitted spreadsheets with annotations or even lengthy written passages. I will accept these, but they will lose points for poor presentation. I predict that most of you in your careers will frequently be called upon to prepare a written report. In my experience, presentation matters! I hope that these projects will hone your skills at writing reports that include quantitative analyses.

The dropbox, whose boss is a computer program, will not accept late proposals or reports. As a result, I will create a dropbox for late submissions. You may ask for an excused late submission; simply state your reason (my dog ate my wifi connection, etc.) and I will decide. An unexcused late submission will receive a minor penalty.

Project 1 Proposal: Due 11:59 PM on Wednesday, February 18, 2015. I want you to perform a balanced CRD with a numerical response. You have seen several examples of such projects in the Course Notes: Dawn’s study of her cat; Sara’s study of golf; Cathy’s and Brian’s studies of running; Reggie’s and Doug’s studies of darts; and Kymn’s study of exercising.

Before you collect data, I need to approve your project. To this end, you need to provide the following information:

1. Discuss, briefly, your choice of a general topic for study. Examples: golfing; running; swimming; bowling.

2. A careful specification of your trials. Examples: hitting a golf ball; running 400 yards; swimming 50 meters; bowling a game.

3. The response you will determine. Remember it must be a number, obtained by counting or measuring. It may not be a dichotomy. Examples: the distance the golf ball travels; the time required to run 400 yards; the time required to swim 50 meters; the score for a game of bowling.

4. The two treatments to be compared. Examples: three iron versus driver; indoors versus outdoors; backstroke versus butterfly; light ball versus heavy ball.

5. The total number of trials in your study; remember, the minimum is 20 and your study must be balanced. If you want to request fewer than 20 trials, make your argument for it.
Note: because bowling is time consuming and expensive, I will accept a balanced study on 10 games.

6. Your choice of alternative hypothesis: $>$, $<$ or $\neq$. Briefly explain your choice.

There is no need to present the above as a story. A simple listing of your six choices will suffice.

A note on the grading of your proposal: If your proposal satisfactorily addresses the issues in the six items above, then you will receive one point. If I need to return your proposal for resubmission, than you might lost part of the one point.

Project 1: Report. Due 11:59 PM on Wednesday, April 8, 2015. Below is a list of items that should be included in your report.

1. Present the six items from your proposal. (With 240 students I cannot remember all proposals and it’s a hassle to look them up.)

2. Present your data in the order you obtained them. For an example of this, see Table 1.1 on page 6 of the Course Notes.

3. Separate your data by treatments and sort them. For an example of this, see Table 1.3 on page 7 of the Course Notes.

4. Obtain the means and standard deviations for the data on each treatment. I don’t care which methods you use to obtain these numbers: by hand; a fancy calculator; a spread sheet; or vassarstats.

   What do these numbers reveal?

5. Draw dot plots of the data on each treatment. For an example of this, see Figure 1.1 on page 8 of the Course Notes.

   What do these numbers reveal? Note: I have had a great deal of trouble with students either not submitting pictures or submitting pictures that I cannot see. For the former case, you will lose 0.2 points; for the latter 0.1.

6. Sort the combined data set and assign ranks to the observations. For an example of this, see Tables 6.1 and 6.2 on pages 118 and 119 of the Course Notes.

   Calculate the mean of the ranks of the data on each treatment.

   Comment.

7. Use the vassarstats simulation option, with 10,000 runs, to obtain an approximate P-value for the test that compares means with your alternative. Be careful: Do not use the t-test P-values; use the resampling/simulation.

   Comment.
8. Use the vassarstats simulation option, with 10,000 runs, to obtain an approximate P-value for the sum of ranks test with your alternative. Be careful: Do not use the t-test P-values; use the resampling/simulation.

Comment.

9. Write a brief summary of what you have learned about your topic.

A note on the grading of the project report. I expect your report to cover all nine items listed above; failure to do so will decrease your score. In particular, I want you to demonstrate your ability to use the vassarstats website.

Hint: In my summer class many students chose treatments that were so different that they obtained total separation in their two sets of data, as Kym did in her study of rowing. With 20 trials this means that the exact P-value for the alternative \( \neq \) is \( \frac{2}{184,756} \). (Do you know why? If not, ask your TA.) In such cases it is very common for the vassarstats simulation to give 0.0000 as the P-value. This is not an error; it simply means that the exact P-value is really tiny, which you should already know because of the separation of the data sets.

Project 2: Proposal. Due 11:59 PM on Sunday, April 12, 2015. I want you to perform/observe 100 dichotomous trials under fixed conditions; i.e., this project covers the materials in Chapters 11, 12 and 14, but not Chapters 15 and 16. When you define your trials and conditions, attempt to make choices so that your total number of successes in 100 trials will be between 18 and 82, inclusive. In other words, don’t make a success too easy or too difficult. If you obtain fewer [more] than 18 [82] successes your grade will be reduced by 0.6 points. (See item 3 in the report below.)

This restriction on the total number of successes you obtain might seem harsh, but I don’t think it is unreasonable to expect you to have some idea of what you are doing! If you are very uncertain about what will happen, you might do a pilot study of, say, 20 trials before you begin your real study. For example, in basketball you might find that shooting lay-ups (shots very close to the basket) yields too many successes while shooting from a distance of 40 feet yields too few successes.

All that I need in this proposal is a careful description of your 100 trials and your definition of what makes a trial a success.

Note: In the past, many students have made errors in defining their trials. Unlike Project 1, you are not asked to compare two ways to do something. Fixed conditions means just collect data one way. For example, if I select (basketball) free throws as my trials, I would pick one way to shoot and then do it. I would not compare left versus right hand; or men’s versus women’s ball; and so on.

Also, survey data are not allowed. As you will see in the description of the report below, it is important to have a temporal ordering of the trials; typically, there is no way to achieve such an ordering with survey data.

Project 2: Report. Due 11:59 PM on Tuesday, May 5, 2015. Your report should include the following information.
1. Tell me again what your trials are.

2. Before you collect data, make a conjecture on the value of $p$; call it $p_c$. You must pick one number for $p_c$: examples include 0.40 or 0.68; do not say: $p_c < 0.50$ or otherwise give more than one number.

3. List your 100 responses in the order they were obtained. Calculate the following:
   - $x$: the total number of successes;
   - $r$: the total number of runs;
   - $v$: the length of the longest run of successes; and
   - $w$: the length of the longest run of failures.

4. Obtain P-values for three tests of the null hypothesis that your trials are Bernoulli trials:
   - Use the runs test with the two-sided alternative. Obtain the approximate P-value by using the normal curve—with continuity correction—with mean and standard deviation given by Equations (11.5) and (11.6) on page 270 of the Course Notes.
     Note that if you obtained $x < 18$ or $x > 82$ then you cannot perform the next two tests and your grade will be reduced.
   - Obtain the approximate P-value—i.e., $P(V \geq v)$—for a one-sided alternative by using the table presented in
     [http://www.stat.wisc.edu/~wardrop/courses/VWdist.pdf](http://www.stat.wisc.edu/~wardrop/courses/VWdist.pdf)
     If your value of $v$ is not in the table, how much larger would it need to be for the data to be statistically significant?
   - Obtain the approximate P-value—i.e., $P(W \geq w)$—for a one-sided alternative by using the table presented in
     [http://www.stat.wisc.edu/~wardrop/courses/VWdist.pdf](http://www.stat.wisc.edu/~wardrop/courses/VWdist.pdf)
     If your value of $w$ is not in the table, how much larger would it need to be for the data to be statistically significant?

5. Regardless of your results in item 4, assume now that your data are from Bernoulli trials and obtain the 95% confidence interval estimate of $p$ two ways:
   - Use the approximate method, even if our conditions for its use are not met.
   - Use the website to obtain the ‘exact’ confidence interval.

   Compare your two confidence intervals and comment. What do your CIs tell you about your conjecture $p_c$?

6. Use the data from your 100 trials to obtain the 90% prediction interval for the total number of successes you would obtain in $m = 200$ future trials. You do not need to perform these additional trials.