# Math 20 Fall 2004
# Application Project Description

## Overview

The linear algebra and multivariable calculus ideas we will study this semester have applications in a variety of fields. Learning about the ways in which mathematical ideas are applied to problems from other disciplines is one of the goals of this course. To that end, you will be required to complete an application project during the semester.

The application project should demonstrate your understanding of a particular problem from the social sciences or other discipline, the mathematical concepts and techniques that can be used to solve the problem, and the ways in which mathematical modes of thought are brought to bear on the problem. The project should be an extension of mathematical ideas or applications seen in this course.

The project will take the form of a properly formatted paper of an appropriate length as well as a poster presentation during Reading Period. Due dates for the components of the project are as follows.

| Component | Due Date |
|---|---|
| Abstract | Monday, April 11th |
| Rough Draft | Friday, April 22nd |
| Final Paper | Friday, May 6th |
| Project Poster | Friday, May 13th |

## Abstract Requirements

Abstracts should consist of a topic and three or four sentences describing your planned treatment of that topic. I am collecting abstracts to make sure that you choose a topic with appropriate scope and difficulty. After reading your abstract, I will let you know if I think your project will be too easy or too difficulty. Failure to turn in an abstract will result in the loss of 10 points from your project grade.

## Rough Draft Requirements

Rough drafts should convey some evidence of work beyond the abstract stage. Your rough draft should contain enough work so that I can comment on it and suggest ways to improve your project. Your rough draft may be submitted in any form you find appropriate. Hand-written rough drafts are acceptable. Failure to turn in a rough draft will result in the loss of 10 points from your project grade. The feedback you receive from me on your rough draft is a valuable part of the learning process, so take advantage of this opportunity.

## Paper Requirements

Most papers should be between 5 and 10 pages (double-spaced), but the amount and type of mathematical notation may result in some longer papers. Several software packages enable one to include mathematical notation in a document, including Microsoft Word (through its Equation Editor tool), Mathematica, and various implementations of TEX. Please ask me if you need help using one of these software packages.

The paper should be written as if to a fellow student in Math 20. Thus you may assume that your audience is familiar with the material we have covered together as a class this semester. You will be graded not only on the depth of your understanding of the application you choose, but also on the clarity of your explanations. Grammar and presentation will be factored into your grade to a lesser extent.

You must include at least 3 references in your project. At least 2 of your references must be print media (i.e., non-Internet). Your textbook does not count toward these reference requirements, although you may cite your textbook. A list of references must appear at the end of your paper, formatted appropriately.

## Poster Requirements

During Reading Period on Friday, May 13th, we will meet in SC 309 and 309a from 2 to 3:30 pm for a project poster session. Your poster should be a science fair style poster, probably on a tri-fold presentation board. Your poster should use text and graphics to convey very quickly the essential ideas in your project to your classmates.

During this session, half of you will be assigned to Group A and half to Group B. During the first thirty minutes, students in Group A will stand beside their posters and explain their projects to the students in Group B, who will be wandering from poster to poster. During the next thirty minutes, the groups will switch roles with students in Group B explaining their projects to students in Group A.

When your group is browsing, you will be given the opportunity to vote on your classmates' projects in the categories of Most Interesting Application, Most Sophisticated Mathematics, and Most Attractive Poster. Winners will be announced at the end of the poster session. Students with winning projects will receive bonus points to their application project grade.

## Advice and Options

You might find a computer algebra system such as Mathematica or Maple helpful in solving the problem you choose for your project, especially if your problem involves real data. We will take a looks at Mathematica's linear algebra functions in class on Monday, April 11th.

Whatever else you do, do not plagiarize! Cite your sources, and consult *Writing with Sources: A Guide for Harvard Students* (`http://www.fas.harvard.edu/~expos/sources/`) for more information on plagiarism. If your life if falling apart and you're tempted to plagiarize to save time or get a good grade, please see me instead. I would rather grant you an extension than send you before the Ad Board for plagiarism.

You may work with one other student on a joint project. You are responsible for sharing the workload with your partner fairly. Joint projects should be greater in either quality or quantity (that is, depth or breadth) than projects submitted by single students.

## Topic Ideas

1. *Leontief Economic Models (§1.6 and §2.6):* Describe one of the Leontief input-output models and its history. Use the model to analyze a relatively simple economy, perhaps one involving actual (if simplified) data. Last year a student used approximate real-world data to analyze the economy of Saskatchewan. Another student used one of these models to look at pollution management issues.

2. *Two-Person Zero-Sum Games:* Find a real-world business or political scenario that can be modeled as a two-person zero-sum game and analyze its optimal strategies. Last year a student modeled certain events in the computer game *Age of Empires* as a two-person zero sum game.

3. *Markov Chains (§4.9):* Analyze the classic real estate board game Monopoly as a Markov process. Determine optimal strategies using Markov chain techniques. The board game RISK also presents opportunities for Markov chain analysis.

4. *Discrete Dynamical Systems (§5.6):* Analyze a population, perhaps using actual birth, survival, and death rates, using the eigenvalue approach to dynamical systems. Last year a student used simplified real-world data to analyze Zimbabwe's population growth.

5. *Linear Programming:* Show how the question of finding optimal strategies for a two-person zero-sum game can be described as a linear programming problem. Use geometric linear programming techniques to find the optimal strategies for a particular game. Last year a student took another approach, using linear programming techniques to solve the so-called "diet problem," the problem of finding the least expensive combination of foods that will satisfy the daily nutritional requirements of a person.

6. *Graph Theory:* Show how one can determine sports team rankings using ideas from linear algebra and graph theory, particularly the idea of the power of a vertex in a graph. Last year one student used these techniques to analyze the ranking of his intramural team.

See also our textbook's web site, `http://www.laylinalgebra.com/`, which contains about two dozen case studies and application projects, some of which would make excellent topics.