In every math class you take, in addition to learning some body of knowledge—some particular collection of definitions, theorems, ideas, and techniques—you should also be learning more about how to *learn* mathmatics and how to *communicate* mathematics.

In Math 340, you should be reaching the point where you can read and make sense of mathematical writing on your own, and be able to communicate mathematics you know in a way that is both understandable to your peers and mathematically precise.

This writing project is your chance to show off those skills. For this project, you will:

- choose a topic related to discrete mathematics that you find interesting,

- read two to three sources for information on this topic,

- write a short paper explaining part of this topic to your classmates.

This is a major project, replacing the second midterm exam.

- Due October 16th: Form groups and choose a topic

- Due October 23rd: A detailed proposal for your project

- Due November 6th (optional): First draft

- Due November 27th: Final project

All documents should be *in my possession* by 11:59pm that day. If you want to turn them in physically, it should be in class that day or in my mailbox by the end of the work day (5pm). They can be turned in by e-mail up to 11:59pm.

## Step 1: Choosing a Topic

You may work in a group of up to 3 people. You can work alone or in a group of 2 if you prefer. I will expect larger groups to take on slightly more ambitious projects. (I'll tell you if your project is substantive enough when you turn in the proposal in Step 2.)

Your group should choose a topic related to discrete math and not covered in this course. It could be an extension of something we've covered, but could also pursue a different part of discrete math. There is a list of ideas for topics on the later, but you don't have to pick from that list.

You should identify two to three sources. For our purposes, you should be drawing from sources that cover significantly more than you'll be able to in your paper to make sure you have enough to work with. Typically that means:

- original research articles (most of these will be very difficult to read, but if you can manage it they're certainly appropriate),

- expository articles,

- textbooks,

- online lecture notes (which are often essentially informal textbooks),

- academic books.

These days you can find lots of these resources online, but you may have to get books from the library (or request them through interlibrary loan). (These are roughly what get called primary or secondary sources.)

Encyclopedias are *not* acceptable sources for this, nor are short notes explaining individual topics. You can certainly use these as supplements or to help you find sources, but they don't count towards your two or three main sources.

Make sure to look at your sources beforehand and check you can understand them. Do *not* just pick a book at the last minute: you'll pay for it later if you can't understand it.

Someone in your group should send me an e-mail no later than 11:59pm on October 16th telling me who's in your group, what your topic is, and what your sources are.

## Step 2: Proposal

By 11:59pm on October 23rd your group should me e-mail with a concrete proposal for your project. This should include telling me what the format will be and roughly what material it will cover.

The proposal has to answer two questions:

1. Exactly what material will the project cover?

2. What format will the material be presented in?

For the first question, ou'll only be able to cover a small fraction of the material in your sources. You should pick out precisely what material you

plan to cover, and roughly how you plan to do it. Most papers will center on presenting a single substantive theorem and its proof, together with enough material to understand the meaning and significance of this theorem.

At a minimum, your proposal should specify:

- exactly which theorem or theorems you plan to include,

- what definitions and lemmas you'll need along the way,

- roughly what your plan for explaining the ideas is (for example, some indication of where you'll include some examples illustrating key ideas),

- roughly what your plan for explaining the significance of these ideas is.

For the second question, the most straightforward choice for a format is to write a paper. I expect these to be about 3-6 papers. (The exact length will depend on the specific topic and what you're covering, so this can be flexible.) If your group prefers, you can present your material in a different format: you could create a poster, or a slide presentation, or a short video, or something else if you have an idea (but run it by me in advance so I can tell you if it's appropriate).

## Step 3: (Optional) First Draft

If you can get me a first draft by November 6th, I'll try to turn around comments and suggestions by early the next week. (If you don't have a full first draft, you can still turn in whatever you have for comments.)

## Step 4: Final Version

The final version of the project is due at 11:59pm on November 27th.

Your paper *must* properly cite *all* sources used. There is no required citation format; use any format you prefer as long as it provides enough information for the reader easily to find the sources used.

You will have the option of distributing your project to your classmates. (You may opt out of this if you wish.)

## Ideas for Topics

Most of these are very broad topics with many potential sources and papers within them. You should be able to figure out a little about them by

searching the internet. If one seems interesting but you're having trouble narrowing it down or finding sources, come talk to me.

Starred topics require a bit more background in other parts of math or in computer science.

| | | |
|---|---|---|
| Propositional (Boolean) logic | Ramsey's theorem | Generating functions |
| Partitions and equivalence relations | Fuzzy logic | Directed graphs |
| Random graphs | Combinatorial game theory | Algorithmic graph theory |
| Spectral graph theory* | Combinatory logic | Information theory |
| Tiling | Hamiltonian graphs | Voting systems |
| The graph isomorphism problem* | Pseudorandom numbers* | Combinatorial identities |
| Cryptography* | Discrete geometry | Relations |

## Grading Rubric

The project grade will be graded out of 100 points based on:

- 5pts: the choice of topic and choice of group is turned in on time with all necessary information.

- 5pts: the proposal is turned in on time with all necessary information.

- 40pts: mathematics—the mathematics is written clearly and correctly, the proofs are rigorous, all necessary steps are present, statements of proofs, lemmas, and definitions are correct, and examples are correct.

- 40pts: exposition—examples are well chosen to illustrate the main ideas, additional writing makes the concepts clear and the arguments easy to follow.

- 10pts: writing—the writing is clear and (mostly) grammatically correct, the citation format is legible.