The assignment and grading

Your assignment in this project is to investigate a topic related to mathematical statistics that we have not covered in class. You will write an expository paper on the topic, hopefully explaining it better than your sources do (and in a manner more particularly suited to your particular audience). You will also present some material related to the topic in class.

Projects will be graded separately in two broad areas, content and writing. Content refers to the mathematical aspects of the paper and how well you have shown that you understand them. Writing refers to clarity of exposition, which includes structure, grammar, spelling, typos, layout, and so forth. While there are many topics available for you to choose from (infinitely many of course!), if you choose a simple topic, you will have to explain it extremely well and demonstrate that you have a solid understanding of it in order to earn a high grade. If you choose a more advanced topic, your explanation and understanding of the material still need to be good but are not held to quite so high a standard as with a simpler topic.

Some words on mathematical writing

One thing to note is that a well-defined structure to your paper is very important, including sections with titles (only the introduction does not need to be titled, since it comes first). This is for many reasons, but perhaps the main one is that people usually do not read mathematical expositions straight through. They find just the bits and pieces that interest them and may often go back and forth within an exposition. If the structure of the paper is not clear, such reading will be very difficult.

Also, be sure to introduce the reader to whatever notation you are using (especially if it is not completely standard), and be sure to define concepts that might be new to your audience. It can be very frustrating to encounter a sentence such as "if $K$ is greater than the Minkowski bound..." when you have no idea what $K$ is (since it wasn't defined earlier) and you don't know what the Minkowski bound is.

And of course, of central importance are well-chosen and illustrative examples, worked out carefully in the paper. These should be clearly labeled and very readable. These examples may or may not be your own (your own being preferable, however), so be sure to cite any sources you are using (within the text, referring to the bibliography).

Some conventions in mathematical writing: variables and the names of other mathematical objects are generally italicized (meaning $x$ and $y$ rather than $x$ and $y$); equations are generally centered and given a little vertical space, such as with

\[2x + 3 = 5;\]
sections are often set off by boldfaced headers (or large-font headers); notation should be used consistently throughout a paper (even if you are consulting multiple sources using different notation!); and it is commonplace to left- and right-justify text (ctrl-j does this in Word, for example), as in this paper.

As for the bibliography, you should certainly have no fewer than two sources, and at least three would be much better. References can be of the form: "As demonstrated in [2], this is patently false", where the [2] refers to a bibliographic entry, such as:


The exact format of the bibliography is not particularly important, as long as you are consistent and provide enough information to direct the interested reader to the source. The bibliography should be cited within the text though (as indicated above) wherever a source is used, and footnotes should not be used instead to cite sources.

**Parts of the project**

Projects will be done individually and will consist of two parts:

1. A paper with no particular length requirement, although I am guessing that most of them will be around 8-10 pages. Make the paper long enough to say clearly what you want to say, and no longer.
2. An in-class presentation of your project for about 10 minutes.

The schedule of events for these is as follows:

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friday, April 23</td>
<td>Topic proposal due</td>
</tr>
<tr>
<td>Wednesday, May 5</td>
<td>Paper due</td>
</tr>
<tr>
<td>Presentation date (TBA in Apr 30- May 5)</td>
<td></td>
</tr>
</tbody>
</table>

*Topic proposal:* In about a paragraph, describe the project that you are proposing, the more specific your description being, the better. I will not collect the topic proposals, but I will instead ask you to explain yours in class on (or before) April 23.

**A brief comment**

Please see me at any point along the way if you would like any help or guidance in selecting a topic or researching or writing your paper. While I certainly won’t do either one for you, I may be able to get you unstuck if you happen to get stuck at some point (including finding a topic).

**About the presentation**

Two brief suggestions in preparing for your presentation:

i. First and foremost, *be absolutely sure to practice by giving your presentation to some other audience (a friend, roommate, etc.) before presenting it to the class*. I cannot
stress the importance of this enough—it helps in so many ways! One important thing it
does is to help you get a sense of the timing of the presentation, which is difficult to
impossible to judge otherwise. Also, it allows you to iron out some of the wrinkles in the
talk, where it you to have trouble presenting or where something you were hoping to
present simply doesn’t work well when presented (in which case it can often be
removed).

ii. Also, if you are using any technology at all, come into the classroom the day
before your presentation or earlier and try it out. Technology is a huge source of
problems in presentations—audio not working, incompatibility of one version of
Powerpoint with another, ... . The list goes on and on. You will need to try everything
out that you can beforehand. Even then, things can go wrong, but at least in that case
they will not be your fault. If you do not try out your technology (in the actual room)
beforehand and something goes wrong with it, your grade will be affected adversely.
Your grade will not be affected by technology that worked when you tried it before (on
the actual equipment to be used) but then inexplicably doesn’t work the day of the
presentation (such as disappearing speakers, etc.).

Also, keep in mind that the purpose of the presentation is not the same as the purpose of
the paper. In the paper, the technical details are to be shown, and you are to demonstrate
your understanding of the topic be working carefully through whatever details need to be.
However, this is not possible in such a short presentation, and it would not be easy to
follow for your audience either. Consequently, in the presentation, the focus must be on
clarity of explanation and not on depth of detail. In short, make the presentation
interesting and accessible to your listening audience; make the paper interesting and
accessible to anyone in the class willing to spend time working carefully through it.

Some possible topics
Some broad areas of interest for these projects include the following. Please keep in
mind though that most of these are broad areas, and perhaps your most challenging task
in this project will be to narrow the topic down sufficiently. Information is certainly out
there and available on all of these topics, but it is way more than you would be able to fit
in such a paper or presentation, so really work to focus your topic sufficiently narrowly.

principal component analysis
statistical mechanics
method of moments
simulation (bootstrapping, jack-knifing, Markov Chain Monte Carlo, etc.)
nonparametric methods (Wilcoxon rank-sum, Kruskal-Wallis, etc.)
linear mixed models (meaning models with random effects)
generalized linear models