

Possible Project Ideas

Here are some possible project ideas, many of which we discussed briefly in class. This is definitely *not* a comprehensive list of possible projects. Indeed, essentially any topic is possible as long as you can relate it to mathematics. If you have an interest that you don't see how to make mathematical, ask me and maybe we can brainstorm something.

- High-dimensional data analysis. We looked at a dataset of natural images but you may have other datasets you'd like to analyze. One tool we discussed briefly in class was Principal Component Analysis (PCA), but there are many other techniques and machine learning tools to explore.
- Modeling problems, such as [problems from the the Mathematical Contest in Modeling](#). Examples include designing and modeling ways to [board an airplane](#), [eradicate ebola](#), [search for a lost airplane](#), [build a traffic roundabout](#), and many others.
- Biology projects. How do you model the spread of a disease? What will the ethnic makeup of the human population look like in 1,000 years?
- Financial projects.
 - How do you predict the future price of a stock?
 - How do you calculate the value of an [option](#)?
 - How do you calculate the risk of an investment?
 - How big must a bank or insurance company's pool of money need to be in order to prevent them from going bankrupt with 99.9% certainty?
- Gambling
 - Powerball simulations (not sure what the math question is but there's definitely math going on here)
 - Model the [Bringing Down The House](#) strategy for making money in blackjack. How many decks does the casino need to use to protect itself?
- Sports projects.
 - How do you predict a team's win-loss record from its players' stats?
 - What's the best route to take to see all of a ski mountain as fast as possible?
 - How do you pick a team for a fantasy competition?

- Variants on the [traveling salesperson problem](#).
- Error correcting codes.
- Cryptography.
- Voting theory. [Arrow's impossibility theorem](#) gives a set of tame axioms that one would want a voting system to satisfy, and then proves that (surprisingly) no such voting system exists. This leaves room for one to consider the pros and cons of various voting systems.
- Who is going to win each state in the 2016 presidential primaries, and how do you model this effectively?
- What is the best way to fit spheres / tetrahedra / dodecahedra / footballs / etc into a box?
- Toppling sandpiles. See [figures 1-4 in this article](#), or the [figure on the wikipedia page](#).
- Variants on the lion and contamination problem mentioned in class. See [this paper](#) or [this blog post](#). If you have more than n lions moving randomly in an $n \times n$ grid, how long do they have to move until you expect them to have cleared the grid?
- Planar graph embeddings. Given a non-planar embedding (there are crossing edges) of a planar graph, what's the minimum number of vertices you must move in order to produce a planar embedding?
- How do you arrange a round-robin tournament where each match consists of three competitors (instead of two)? You could ask that each possible triplet competes exactly once, or you could instead ask that a competitor is matched in a triplet with every other competitor exactly once.