# CS 186 Project Proposal

Tiffany (Haotian) Wu and Luis Antonio Perez, Harvard University

April 14, 2015

Dear course staff: please advise as to which proposal you prefer!

## Proposal Idea #1: Harvard Prediction Market

We think it would be interesting to propose a prediction market for Harvard students only (possible expansion to other schools later). The market could be used to predict exam difficulty, final grades, or other Harvard-specific events. Our finished product would be a paper outlining the proposed mechanism. One paper that we'd base our framework on details the proposal for "Prediction Markets To Forecast Electricity Demand".[1]

Parameters we'd have to flesh out are what "things" students would bet (Harvard students are known to be competitive, so I think a nonmonetary system with points would work equally well, with the ability to go into the negatives but not unboundedly). Analysis would also include whether or not it would be useful to manipulate the market, and to decide between binary or continuous contracts. Since we did not study continuous contracts in depth, we would do some research as to how these are implemented in practice, as well as decide how to clear the market (eg. CDA).

One issue we had with this idea is that it would be difficult to implement and test within the time-frame of the final project. However, we think a paper proposal is certainly feasible, and furthermore, could later be expanded into a type of entrepreneurial venture. That aspect could also be addressed in a section of the paper to incorporate network cascades into the mix.

**Concerns:**

- What kind of continuous contracts do you think would be best (if any)? (depending on the median). In the case of grades, should we base point rewards on the number of standard deviations between their estimate and the actual estimate?
- How might we normalize point value over different auctions? If the same point pool is used to predict exam difficulty and final grades, how might a reasonable "rate of exchange" balance be struck?

## Proposal Idea #2: Diffusion Network Models

Our idea is to study the topic of network modeling more in-depth and provide a more complex model for network behavior. In particular, we're interested in the theoretical properties of soft-threshold models and extensions of these soft-threshold models to what we term "diffusion" models.

[1] The paper (Castro, Cramton, 2009) can be found here:
http://www.kellogg.northwestern.edu/faculty/decastro/htm/personal/predictionmarketsforelectricity.pdf.

A diffusion model, as we understand it so far, is a graph model where edge weight represent the level of influence between two vertices, $i, j$. Intuitively this could represent the "emotional intensity" or "intimacy" between two individuals [2]. We want to study the properties of these "diffusion" networks, especially when a source influence can "diffuse" only partially through the graph (agents are continuous, rather than binary in nature).

Our intuition is that a "diffusion" model of information is more interpretable than a soft-threshold model. However, we also belief that the theoretical results for the soft-threshold model studied in class and our "diffusion" model will be equivalent in expectation. A specific question we wish to explore, then, is the cascading behavior of "diffusion" models. What are the theoretical properties that might lead to a cascade is this new model? Can the soft-threshold, independent cascade model be shown to be equivalent to our intuitive, diffusion model?

In order to explore the above questions, our project would involve understanding current network model research – with a focus on cascade creation and blocking. By understanding other models, we would be able to better construct our own intuitive model. Additionally, our project would involve creating simulations on both cascade models (as well as others, depending on time constraints) that would allow use to empirically verify theoretical results. If time allows, we're also open to further exploration of network behaviour under our new model, such as definitions of new, useful properties of the graph, exploring the effect of differing topologies on our model, etc.

**Concerns:**

1. We're concerned that the "diffusion" model is too simplistic or has already been thoroughly researched. Preliminary research shows that this is not the case – however, we're not as familiar with the literature as you, so feedback in this regard is greatly appreciated.

2. As you can tell, we're interested in creating a model which more closely resembles real-world networks. Could you point us to literature that explores this idea? We'd love to do more research.

[2] Granovetter, M., 1973. The strength of weak ties. American Journal of Sociology 78(6), 1360-1380 https://sociology.stanford.edu/sites/default/files/publications/the_strength_of_weak_ties_and_exch_w-gans.pdf