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*ECON 1071 / CS 37: INCENTIVES IN THE WILD:
FROM TANKING IN SPORTS TO MINING CRYPTOCURRENCIES*
Harvard Hall 201, M/W 1:30–2:45, Fall 2023

SYLLABUS

Version 1.02

A. COURSE OVERVIEW

How could it be that paving a new road might increase congestion for all drivers? Why would a professional sports team ever try *not* to score in a game that it wants to win? Why would any student rank high schools not in their order of preference when applying? And what are some incentive pitfalls that the designer of a cryptocurrency system should be aware of? In this course, we will examine seemingly strange social phenomena, use mathematical tools to model them and to analyze how and why distorted incentives give rise to them, and explore potential mechanisms to eliminate such phenomena.

Recommended prep: We will assume mathematical proficiency consistent with having already taken Stat 110 and having already taken or concurrently taking Math 21a.

B. BEFORE THE SEMESTER STARTS

I will hold a virtual office hour on August 17 between 3pm–4pm to answer questions about the course. No need to register—just join at <http://yannai.gonch.name/zoom>.

To petition to take the course, please BOTH petition on my.harvard AND fill out the petition questionnaire using the link posted on the course website on Canvas under “Announcements.”

C. COURSE WEBSITE

Information and materials relevant to the class will be distributed on the course Canvas website (<https://canvas.harvard.edu/courses/122224>).

D. OFFICE HOURS

I encourage you to make office hours appointments with me throughout the semester to discuss your final project. To do so, please send me an email describing what you would like to discuss (e.g., a paragraph- or page-long description of the project idea) and some blocks of time that are convenient and we can set up an appointment. (There are also two pre-scheduled meetings on the project—see Section K below.) Please feel free to reach out to me and make office hours appointments also regarding anything else.

We are very fortunate to have Bnaya Dreyfuss and Sara Fish be the TFs for this course. The schedule of their office hours and sections will be determined by a poll of enrolled students to be sent out during the first week of class.

E. WRITING ASSIGNMENTS

Beyond presence in all lectures, which is expected, there are three assignment types in this course (in increasing order of importance): (1) (light) homework problems, (2) taking notes and writing down thoughts on one lecture, and (3) a final paper.

E1. Light-Load Problems

After some lectures, homework problems will be given. These are not meant to be particularly time consuming (if they are, please let us know and we will recalibrate). The goal of these light-load

problems is to help you make sure you have understood certain concepts from class. Therefore, and as most lectures are self-contained from a mathematical/technical viewpoint, these will be graded on completion, i.e., showing that you have made reasonable effort, and are providing sensible solutions. (Wrong solutions can also be sensible! On the other hand, we checked, and GPT has a tendency to provide solutions that we would likely deem non-sensible; see Section J below regarding using GPT and similar tools.) Some problems will be designated as bonus problems, and are optional. For simplicity, we will have three problem-set submission dates throughout the semester:

- October 2: Problem set 1 (equilibria, routing games, auctions)
- November 1: Problem set 2 (unraveling, matching)
- November 27: Problem set 3 (voting)

We highly recommend that you start working on a problem once it is given, and not wait for the deadline to work on all of the problems that are due. You are welcome (and, in fact, encouraged!) to discuss the homework problems with other humans, but you must write up your solutions yourself and in your own words. (As for discussing with non-humans, see Section J below.) Additionally, you must list the names of the students with whom you collaborated (if any). Copying someone else's solution, or just making trivial changes for the sake of not copying verbatim, is not acceptable. Please submit on Canvas in electronic form (preferably typed up, otherwise a clear scan of legible handwriting) by 11:59pm ET on the due date.

A total of three late days (72 hours) are allowed over the course of the semester. These are applicable to problem sets and to lecture notes and thoughts, but *not* to the final project. If and how you use this "budget" is completely up to your discretion, but we do ask you to send an email to *both* Bnaya (bdreyfuss@g.harvard.edu) and Sara (sfish@g.harvard.edu) *in advance* (i.e., *before* any deadline that you wish to extend) and clearly state how long of an extension you are using.

E2. Lecture Notes and Thoughts

Each student will be asked to take notes on one lecture, and, in addition, to write down their thoughts—one page discussing possible applications and critically discussing limitations—about the material of the lecture. Sign-up sheets (first-come first-serve, with a small bonus to the first student who signs up for each lecture date) will be posted on the course site on Canvas. The notes and the discussion page should both be typed and submitted as separate files to *both* Bnaya (bdreyfuss@g.harvard.edu) and Sara (sfish@g.harvard.edu) within one week after the lecture. (You may apply any part of your 72-hour budget toward an extension of this deadline as well; as always, please make sure to email *both* Bnaya and Sara before your deadline.) Notes will be evaluated on accuracy and clarity, and discussions on insight. Notes (but not discussions) will be posted to the course website.

E3. Final Paper

The main assignment for this course is to write a final paper. The paper should discuss a real-life social phenomenon that you have observed, from an incentives perspective. There need not be a concrete full explanation for the phenomenon or a mathematical treatment. You are expected, however, to argue the importance of understanding this phenomenon, and in particular why the current observed behavior is not optimal from a societal viewpoint. You are also expected to search for possibly relevant literature, and attempt to give a plausible qualitative (at least) explanation for the phenomenon. Extra credit will be given for some level of mathematical treatment and/or suggested solution. Expected length is about 15 pages. If less than 10 pages, then they should be of such high quality that it would be abundantly clear that more pages would be redundant.

Suggested outline (not all questions suggested for each section need be answered):

- **Title, authors, and abstract (1 page combined)** — The abstract (up to 200 words) should be enough for the course faculty to refresh their memory on the gist of your paper. Write this last.
- **Section 1 (up to 3 pages): Introduction** — Write this only after you have finished all the other sections (except the abstract). The introduction should be written so that a curious

reader with no higher-education background will be able to follow it. The level of detail should be comparable to that of a “newspaper story” about your project.

- **Section 2 (up to 3 pages): Phenomenon description** — What is the phenomenon? Why is it important and/or interesting? Why is the current observed behavior or outcome not optimal from a societal (or other) viewpoint? What outcome would you aim for? What do you think could give rise to this suboptimal outcome? (Distorted incentives? Information gaps/asymmetries? Something else?)
- **Section 3 (up to 3 pages): Literature review** — Which related scholarly articles did you find? For each article: (1) how is it related? (similar setting? similar underlying forces? similar to your proposed approach? related in some other sense?) (2) What is the high-level “gist” of the article? (You would usually not need to read beyond the introduction.) Also contrast and compare the different articles, if/where relevant. If you happen to find any other relevant trustworthy sources, you are encouraged to discuss them as well, but not instead of looking for published academic work.
- **Section 4 (up to 6 pages): Suggested approach** — Give one or more plausible explanations for the phenomenon. Try to be as specific as you can (e.g., if the phenomenon is at Harvard, discuss explanations for this specific phenomenon rather than for similar phenomena in abstract universities). Start with a qualitative explanation. If you can make it mathematically formal then that’s great, however mathematical modeling is neither necessary nor sufficient for getting a good grade. If you gave more than one plausible explanation, how would you go about trying to rule some explanations out? Could you suggest a high-level approach to solve or even mitigate the phenomenon assuming that your explanation(s) is right?
- **Section 5 (one page): Conclusion** — discuss your findings, including their strengths, weaknesses, and if any, ideas for other applications.

This assignment should be in groups of five students (if the number of students is not divisible by five, then some groups of four will be allowed). The timeline is as follows:

- **By Sep 18** (by 11:59pm ET): Submit list of group members.
- **By Sep 25**: Write a one-page proposal of a project idea.
- **By Oct 2**: Write a one-page proposal of a second, separate project idea.
- **By Oct 16**: Choose between the two ideas, and submit a comparative discussion of pros and cons of each idea, which explains your choice.
- **By Oct 23**: Submit Section 2.
- **By Nov 6**: Submit Section 3.
- **By Nov 22**: Submit Section 4.
- The final project presentations are planned for the last few sessions of the class (likely 10- to 20-minute presentations, depending on the number of projects), and are a great opportunity to give and get feedback from your fellow students.
- **By Dec 10**: (last day of reading period): Submit the final version of the final paper (title, abstract, Sections 1–5). This is a hard deadline imposed by the school, and cannot be extended.

E4. Final Grade

The final number grade of the course, in a scale of up to 100, will be calculated as follows:

- 75% final paper
- 15% lecture notes and thoughts
- 10% problem sets (could be increased beyond 10 points by correctly solving bonus problems)

In cases of consistent exceptional participation in lectures, we might increase your final number grade by up to 4 points. Repeated unjustified absences, or late submissions beyond the 72-hour budget, might result in a grade deduction. When converting the final number grade into a letter grade, number grades of 95 or higher will be considered an A, other number grades of 90 or higher will be considered an A-, other number grades of 85 or higher will be considered a B+, etc.

F. FALLING BEHIND

If you are starting to have difficulties in this course it is imperative that you come talk to us before you are so far behind that it is impossible to catch up. We want you to succeed in this course and are here to help you do so!

G. STUDENT WELLBEING

Your physical and mental wellbeing is of utmost importance to us, and I recognize that all that is going on in the world right now can make this an especially difficult time. You never owe me personal information about your (mental or physical) health, or anything else. However, feel free to talk to me about things that you are going through. If I can't help you, I may know somebody who can, and I will do my best to connect you to that person. If you need extra help, or you need to miss class, or need more time with something, just ask. I promise we will work with you.

There are also a number of resources available to you on campus to support your wellness, including Counseling and Mental Health Services (CAMHS), which can be reached at 617-495-2042, or you can visit their website <https://camhs.huhs.harvard.edu/find-help-now>. Please see “Support Resources” on the course site on Canvas for more resources. If you or anyone you know experiences any high levels of stress, difficult life events, or feelings like anxiety or depression, I strongly encourage you to seek support.

H. DIVERSITY, INCLUSION AND BELONGING

My goal is to create a learning environment that supports a diversity of thoughts, perspectives and experiences, and honors your identities (including race, gender, class, sexuality, socioeconomic status, religion, and ability). I (like many people) am still in the process of learning about diverse perspectives and identities. If something was said in class (by me or anyone else) that made you feel uncomfortable, please talk to me about it. If you feel like your performance in the class is being impacted by your experiences outside of class, please don't hesitate to come and talk with me. As a participant in offline and online course discussions, you should also strive to honor the diverse perspectives of your classmates and teaching staff.

I. ACADEMIC INTEGRITY

Members of the Harvard University community commit themselves to producing academic work of integrity—that is, work that adheres to the scholarly and intellectual standards of accurate attribution of sources, appropriate collection and use of data, and transparent acknowledgement of the contribution of others to their ideas, discoveries, interpretations, and conclusions. Plagiarizing or misrepresenting the ideas or language of someone else as one's own, or any other instance of academic dishonesty violates the standards of our community, as well as the standards of the wider world of learning and affairs.

J. USE OF LARGE LANGUAGE MODELS (LLMs)

Tools based on Large Language Models, such as GPT and Bard, are here to stay. They encapsulate exciting possibilities, but also present challenges and potential pitfalls. The use of LLMs (subject to the above) is allowed in this course but must be disclosed as follows. If you use LLMs for any assignment, you are required to submit, with the assignment, a full transcript of each query to the LLMs together with the LLM's response. Regardless of whether or not you use LLMs, your work will be graded based on its content alone (i.e., the content would be graded as if written completely by you). In particular, the responsibility for the content of your submitted work lies solely with you, regardless of whether any LLM assisted you with its generation. This includes, but is not limited to, making sure that your academic work is of integrity as detailed in Section I above.

K. CLASS SCHEDULE

Below is the list of dates at which lectures will be held. The list of topics below is tentative and subject to changes based on class interest, class dynamics, world events, etc. (in which case, some of the problem-set submission dates from Section E1 above might be postponed but would not be moved earlier).

Notice that on two Wednesdays (Oct 4 and Nov 8), in lieu of a lecture we will hold individual meetings with the project groups to advise you on your final projects. As indicated below, whichever groups do not get a chance to meet with us on that Wednesday will meet with us on Friday two days later. (We will schedule the group meetings for these Wednesdays and Fridays well in advance, and will do our best to take your time constraints into account.) We expect all group members to be present and participate in their groups' meetings.

- **Sep 6:** Bird's eye view: course intro and sampler.
- **Sep 11:** How could paving a new road worsen everyone's commute time?
- **Sep 13:** How could paving a new road worsen everyone's commute time? (2)
- **Sep 18:** Why do auction sites charge you less than your bid?
- **Sep 20:** Why do auction sites charge you less than your bid? (2)
- (Sep 25 — Yom Kippur — class canceled)
- **Sep 27:** What would make oil-rights auction winners go bankrupt more often than residential-land auction winners?
- **Oct 2:** Why are there less dealerships for outstanding-quality used cars than we might expect?
- **Oct 4+6: Group meetings** with Yannai, Bnaya, and Sara regarding choice of topic for final project.
- (Oct 9 — Indigenous Peoples' Day — no classes)
- **Oct 11:** Why did hospitals in the 1940s offer post-graduation internships to sophomores, three years in advance of graduation, instead of waiting to see how they fare on their studies?
- **Oct 16:** Why did hospitals in the 1940s offer post-graduation internships to sophomores, three years in advance of graduation, instead of waiting to see how they fare on their studies? (2)
- **Oct 18:** Why would some students rank schools *not* by their "true" order of preference when applying?
- **Oct 23:** Why would some students rank schools *not* by their "true" order of preference when applying? (2)
- **Oct 25 (Guest Lecture by Bnaya Dreyfuss):** Does each student even have a "true" order of preferences when applying?
- **Oct 30 (Guest Lecture by Bnaya Dreyfuss):** Does each student even have a "true" order of preferences when applying? (2)
- **Nov 1:** Who should win in an election if a majority prefer a to b, a majority prefer b to c, and a majority prefer c to a?
- **Nov 6:** How should we aggregate individual preferences to form group preferences?
- **Nov 8+10: Group meetings** with Yannai, Bnaya, and Sara regarding progress on final project.
- **Nov 13:** Why would anyone vote not according to their preferences?
- **Nov 15:** Despite more and more refined rules, why do professional sports teams still sometimes try to lose on purpose?
- **Nov 20:** In cryptocurrencies, to a large extent no one enforces the rules. So why should people play by the rules nonetheless?
- (Nov 22 — Thanksgiving Recess — no classes)
- **Nov 27:** Could the requirement of unanimous conviction cause more wrongful convictions?
- **Nov 29:** Final project presentations
- **Dec 4:** Final project presentations