Lecture 10
Incentive Design: Badges and Attention

Instructor: Chien-Ju (CJ) Ho

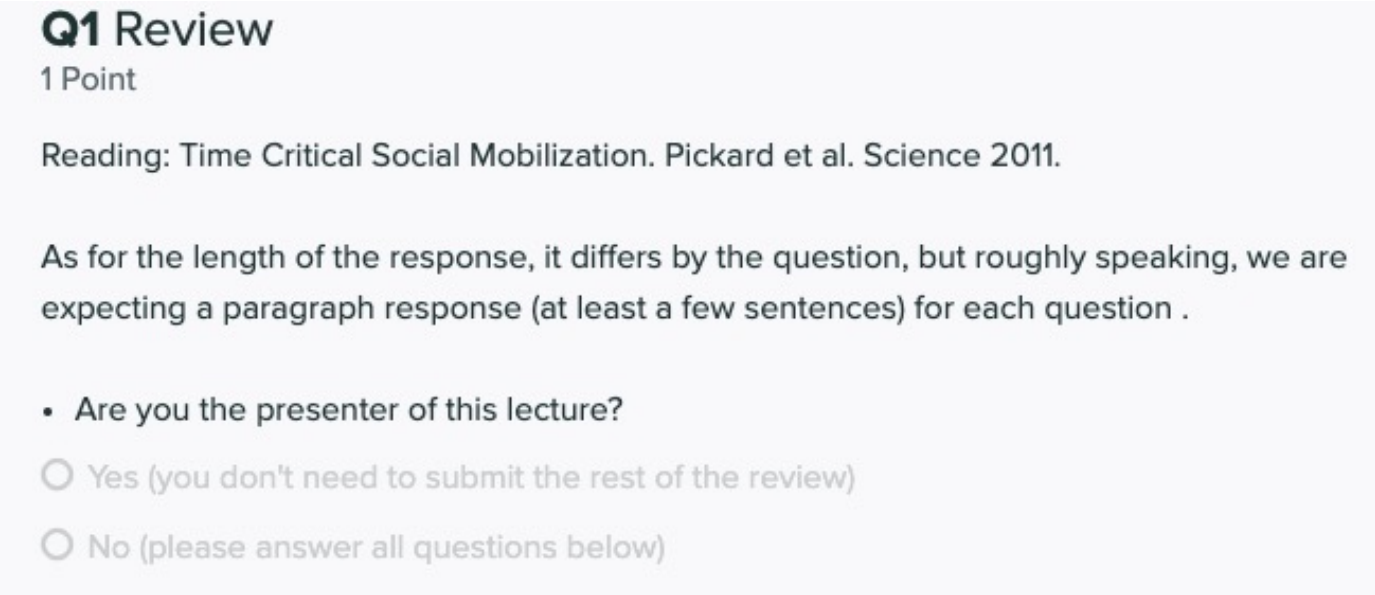
Logistics: Deadlines

- Assignment 2: Due this Friday
- Assignment 3: Due Oct 13 (Wed)

- Project milestone 1: Due Oct 15 (Fri)
  - Initial literature survey (know what other works are out there)
  - A plan on what you want to do for the remaining of the semester
    - Formalize your research question and approaches, e.g.,
      - Theory/simulation project: formalize your models
      - Data-analysis project: figure out where and how to get data and what you plan to do with it
      - Experiment/application project: have a prototype design and an evaluation plan
    - Include a timeline (weekly or biweekly) on what you plan to do
      - Nov 2: Midterm Project Pitch
      - Nov 5: Milestone 2

Logistics: Review Submission

- For book-keeping purposes, if you are the presenters of the lecture, please answer a single question for the review of your lecture.



Recap on Game Theory Basics

Game Theory Basics

- Key elements of game theoretical models
  - Players, strategies, payoffs

- Normal-form game

B

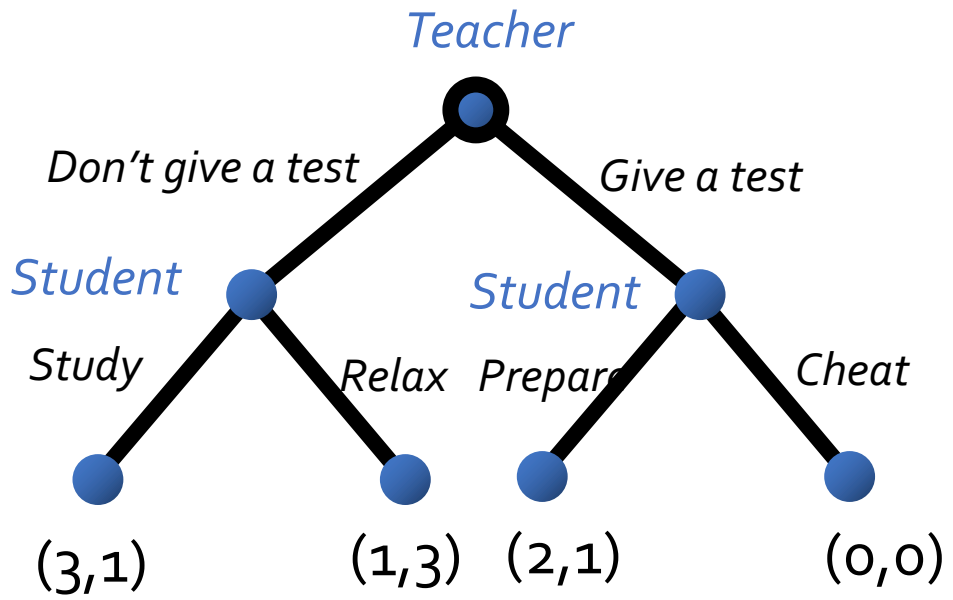
A

	Stay Silent	Confess
Stay Silent	A: 6 months B: 6 months	A: 10 years B: free
Confess	A: free B: 10 years	A: 5 years B: 5 years

Game Theory Basics

- Key elements of game theoretical models
  - Players, strategies, payoffs

- Extensive-form game



Solutions Concepts

- Informally, predictions of what rational agents will do given the game

- Nash equilibrium
  - If everyone else follows Nash equilibrium, it's your best interest to follow

B

A	Movie	Bar
Movie	(2, 1)	(0, 0)
Bar	(0, 0)	(1, 2)

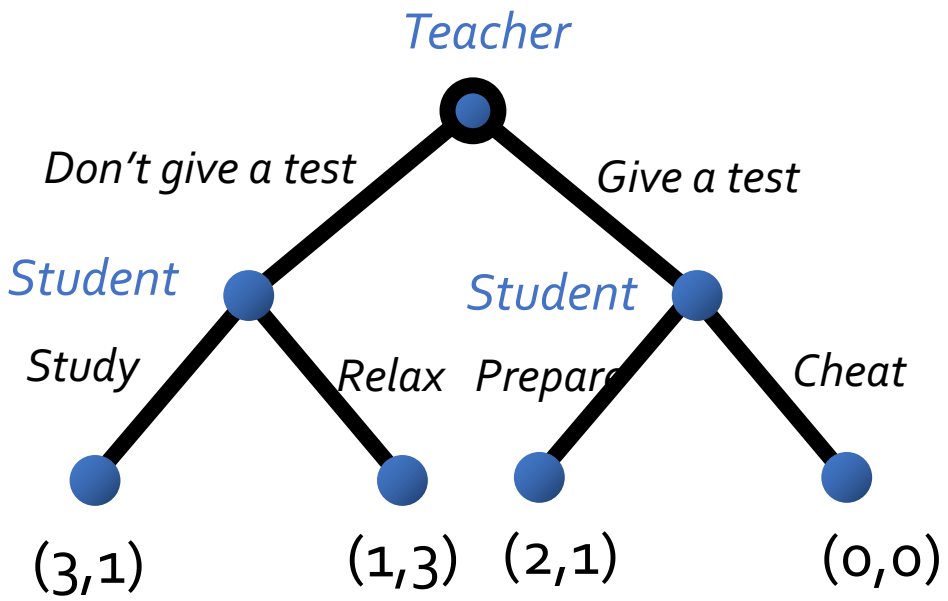
(Movie, Movie) and **(Bar, Bar)** are pure strategy Nash equilibria

Generally speaking, finding a Nash is hard, but verifying whether it's a Nash is easy

Solutions Concepts

- Informally, predictions of what rational agents will do given the game

- Subgame perfect equilibrium
  - Play in each ”subgame” is a Nash equilibrium



- Subgame perfect equilibrium
  - Teacher chooses “Give a test”
  - Student chooses (“Relax”, “Prepare”)

Mechanism Design

- Game theoretical analysis
  - Given the game, analyze what rational agents will do

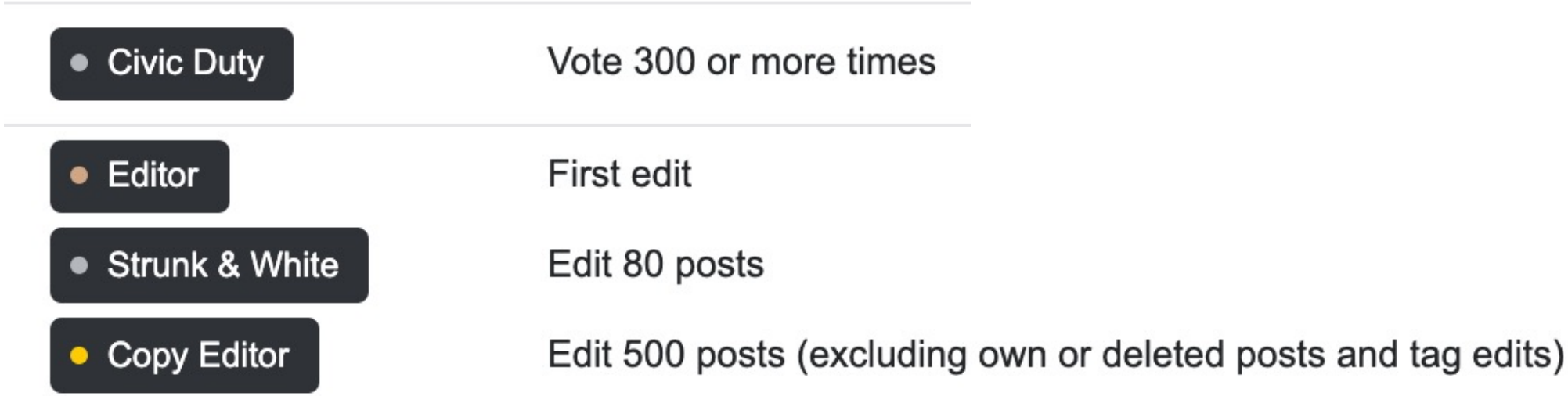
- Mechanism design (reverse game theory)
  - Give a goal of what you want rational agents do, design the game rules (e.g., what payoffs agents can receive) such that agents choose the actions you want them to choose.

Badge as Incentives

Steering User Behavior with Badges. Anderson et al. WWW 2013.

Modeling Badges

- Focus on threshold badges



- Representation of threshold badges:
  - Earn a badge for “taking an action K times”

Modeling Badges as Incentives

- Key elements in modeling incentives
  - Players, Action space, Payoff
- One naïve model for threshold badges
  - Players: Only single user since there is no user interaction in threshold badges
  - Action space: # actions the user decides to take
  - Payoff: Utility(HasBadge(# actions)) - Cost(# actions)
- Model prediction: Users take actions that maximizes payoff
- This model helps answer some questions but not others
  - What can this model tell us?

All models are wrong
but some are useful

George E.P. Box

Modeling Badges (Action)

- Interactions between different types of actions.

  Introduce action types $(A_1, \dots, A_n, A_{n+1})$, where A_{n+1} is the "life action"

- Sequential decision making instead of one-shot decision

  User history is summarized in a vector $\boldsymbol{a} = (a^1, \dots, a^{n+1})$

  a^i: # times actions of type i has been taken

  The user can only take one (mixed) action at a time

  User policy $\boldsymbol{x}_{\boldsymbol{a}}$: given history $\boldsymbol{a}$, the prob. distribution over action types

Modeling Badges (Payoff)

- Cost of actions

  User have a preferred (mixed) action $\boldsymbol{p}$

  Cost for take action $\boldsymbol{x}$: $g(\boldsymbol{x}, \boldsymbol{p})$ distance to the preferred action

- Utility for obtaining badges

  Value of the badge b: V_b (assume this is given)

  Indicator function of whether the badge is obtained

$$I_b(\boldsymbol{a}) = \begin{cases} 1, \text{if the history } \boldsymbol{a} \text{ qualify for badge} \\ 0, \text{ otherwise} \end{cases}$$

Modeling Badges (Payoff)

- Discounted future payoff
  - The payoff in the next round is discounted by $\theta = 1 - \delta < 1$
  - Users aim to choose policy $\boldsymbol{x_a}$ that maximizes $U(\boldsymbol{x_a})$

$$U(\mathbf{x_a}) = \sum_{b \in B} I_b(\mathbf{a}) V_b + \theta \sum_{i=1}^{n+1} \mathbf{x}_\mathbf{a}^i \cdot U(\mathbf{x}_{\mathbf{a}+\mathbf{e}_i}) - g(\mathbf{x_a}, \mathbf{p})$$

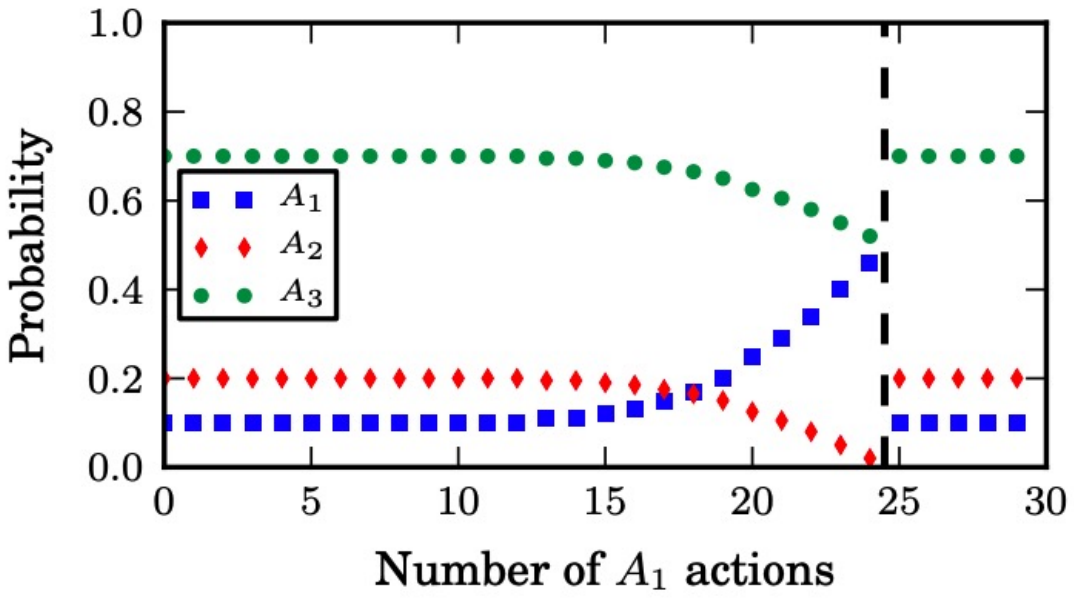
Payoff from current badges

Payoff from "future" badges from actions

Cost of action

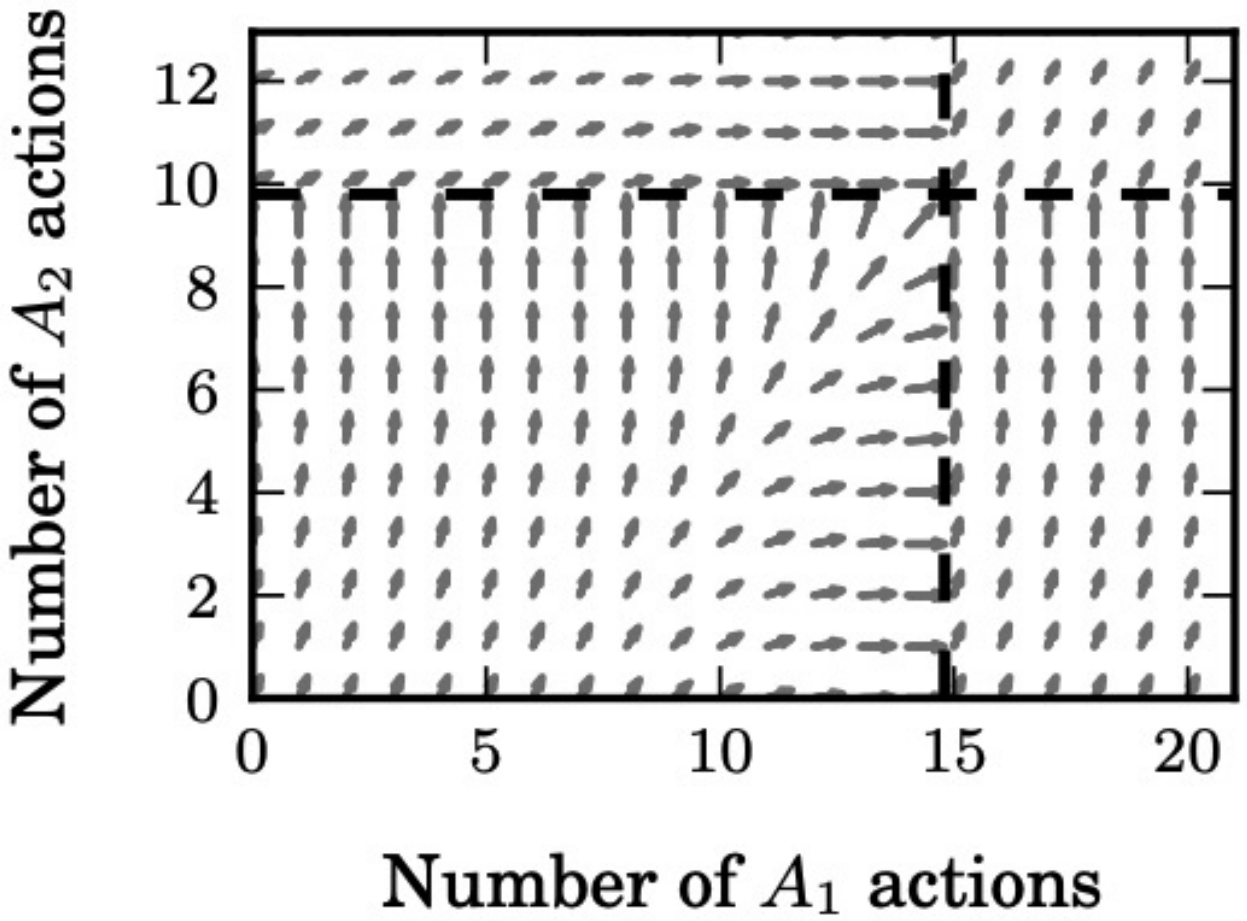
Think about what actions users will take if we believe this model is correct?

Model Predictions



- More sensitive to badges when closer to obtaining it.
- Increase the action of one type decrease the others.
- The incentive of a badge disappears after obtaining it.

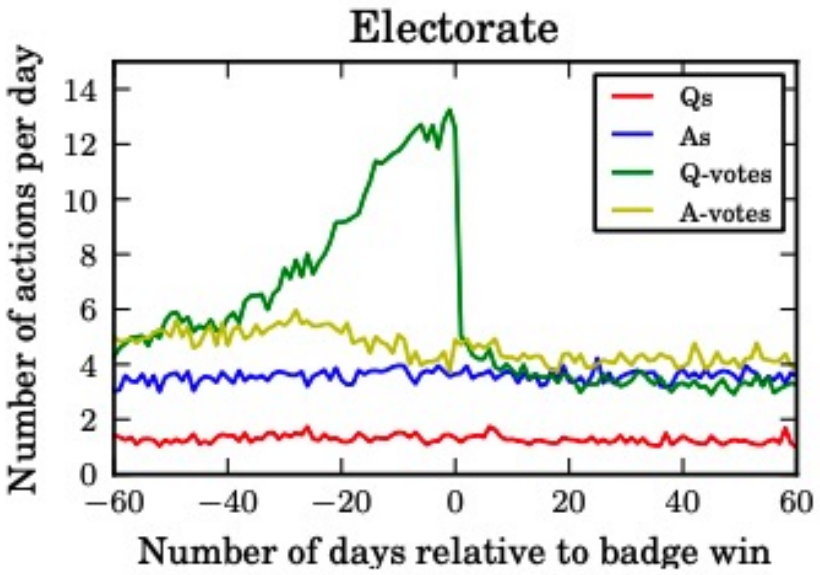
Model Predictions



Empirical Evidence from Stack Overflow

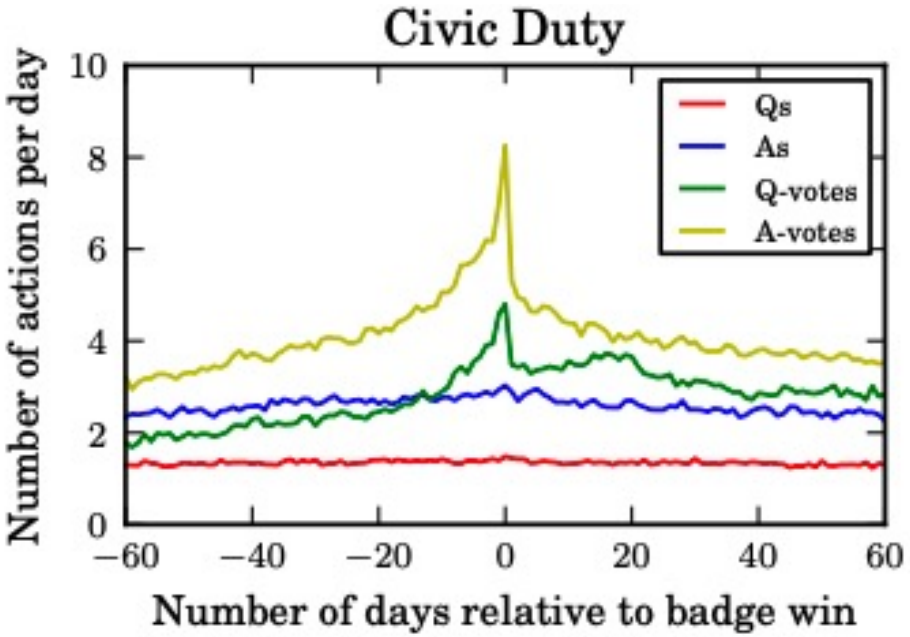
Electorate

Vote on 600 questions and 25% or more of total votes are on questions



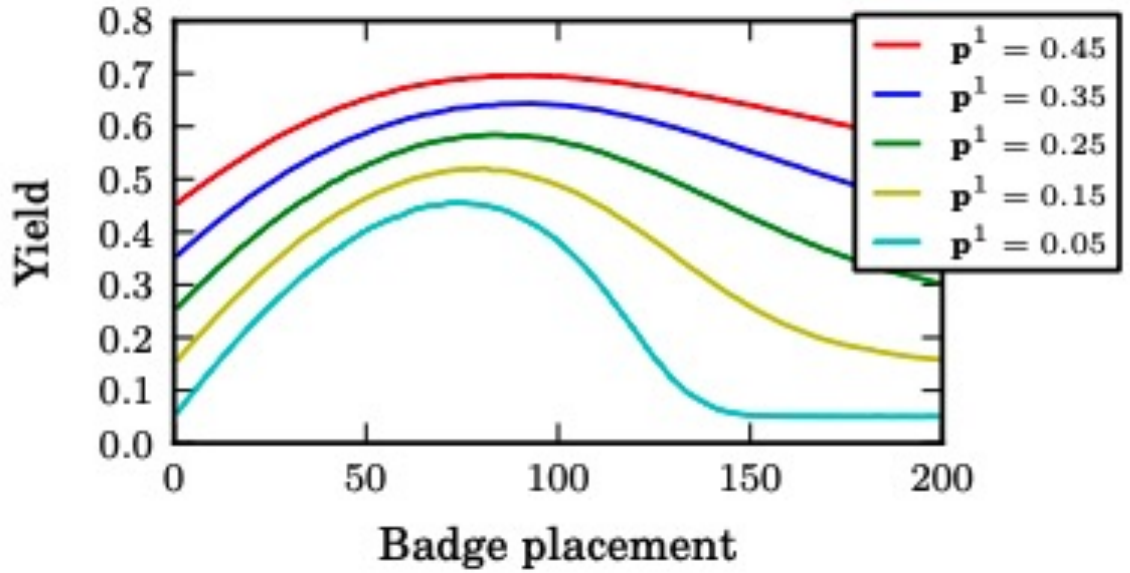
Civic Duty

Vote 300 or more times



Badge Design

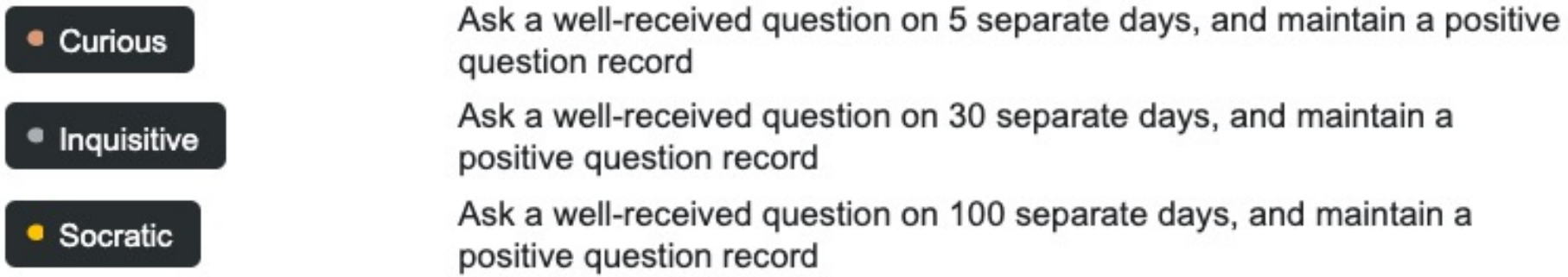
- How to optimally design the badges?
- Single threshold badge: what is the optimal threshold



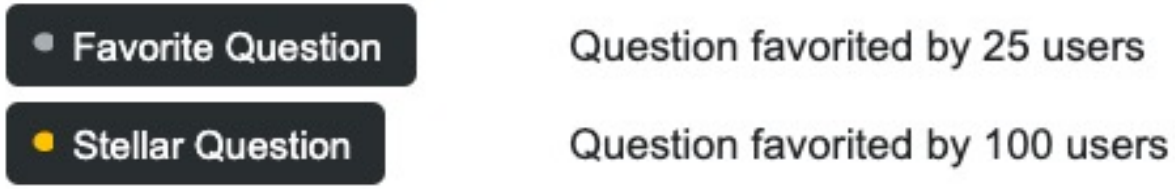
The paper discusses more design questions, but be careful on what the model/evidence really captures.

Other Badges

- Requires a “sustained” performance



- Associates with quality



- And more …(e.g., requires competition)

Final Notes

- Connections to gamification, social status, and reputation systems.

- For all these modeling work, try to always remind yourself what the settings/assumptions are, and consider when/whether they might be useful.

Discussion

- Have you ever been incentivized by badges? Share your experience with other students.

- Discuss on whether those badges can be designed better? Try to more formally describe the aspects of design and define what you mean by better.
  - Think of this as a practice to ”model” the world that you care about.

- What additional features/perspectives do you think are the most interesting/important next questions to ask for badge design?

Attention as Incentives

Incentivizing High-Quality User-Generated Content. Ghosh and McAfee. WWW 2011.

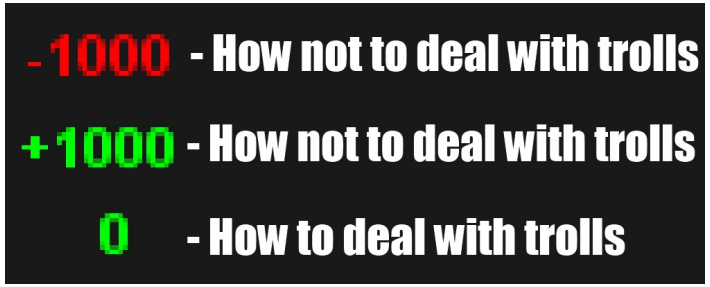
User-Generated Content Platforms

- Content is generated by users instead the platform

- **Why** do people post content on YouTube, Instagram, Quora?

Attention is One of the Major Incentives

- Psychological motivation



- Probably more importantly,
  Attention => Money (e.g., through advertisements)

https://www.digitalinformationworld.com/2020/03/you-vs-the-world-s-highest-paid-youtubers.html

- Platforms have huge power on influencing which content will receive more attention

Assuming attention is the main motivation for contributors, how should the platform design their content displaying algorithm?

Modeling Attention as Incentive

- Players: Platform, Users
- Actions:
  - Extensive-form game: the platform takes action first, then users take actions
  - Platform: Content displaying mechanism
  - Users: quality of the contributed content
    - Simplification: Quality $q \in [0,1]$: a ratio of q viewers will like the content
    - Higher cost to generate better-quality content
- Payoff:
  - Platform: some function of the quality of all content on the platform
  - Users: Utility(# views(quality)) – Cost(quality)
- Solving the equilibrium (everyone is taking the best-response action)

More Settings/Assumptions

- The platform aims to allocate M views to K contributors (assuming viewers just read/watch whatever the platform recommends)

- Extensive-form game
  1. The platform announces her allocation mechanism
  2. K contributors simultaneously decide on the quality of their contributions

  Each contributor aims at maximizing Utility(# views(quality)) – Cost(quality)

Mechanisms

What are the outcomes of the mechanism?

Assumption: Each contributor aims at maximizing Utility(# views(quality)) – Cost(quality)

- Random: randomly allocating M views to K content

Flood of bad content

- Proportional mechanism:
  - Let $q_1, \dots, q_K$ be the quality of the K content
    - (assume q means the ratio of viewers who like the content)
  - Content i receives $M \frac{q_i}{\sum_{j=1 \; to \; k} q_j}$ views

Requires good estimate of q

Quality converge to a suboptimal value

- Can we do better?

Mechanisms

What are the outcomes of the mechanism?

Assumption: Each contributor aims at maximizing Utility(# views(quality)) – Cost(quality)

- Elimination mechanism:
  - Each content is evaluated by a random select of A viewers
  - Only when all A viewers like the content, it goes to the 2nd stage
  - All content in 2nd stage equally shares the remaining views

By tuning A, content quality might achieve optimal

Simultaneously estimate content quality.

Additional follow-up work

- Mixture of learning and incentives: [Ghosh and Hummel. ITCS 2013]
  - Showing a content to viewers:
    - Create incentives for contributors
    - Platform can learn content quality from viewer feedback
  - How to simultaneously address joint issues of learning and incentives

- Incorporating human biases in learning [Tang and Ho. AAMAS 2019]

Herding Effect

Discussion

- We have discussed the incentive design problem for financial incentives and non-financial incentives such as badges and attention.

- What are the other types of incentives you think we can utilize to promote human-in-the-loop computation?
  - Reputation, access to information, recommendation accuracy, etc

- How do you model and analyze the incentives?
  - Players, actions, payoff? What's the equilibrium?
    How to perform the design?

Assignment 3

Cooperation and Repeated Prisoner's Dilemma

- Prisoner's dilemma predicts that people are not going to cooperate in the game setup, but in practice, people sometimes do.

		Player 2	
		Cooperate	Defect
Player 1	Cooperate	(2,2)	(0,3)
	Defect	(3,0)	(1,1)

- Will look at this using repeated versions of prisoner's dilemma
  - Sequential decision making
  - Discount utility u_t obtained at time t by δ^{t-1}, with $\delta \in (0,1)$

$$U = \sum_{t=1}^{T} \delta^{t-1} u_t$$

Peer Grading and Peer Prediction

- Can we design ”incentives” for peer grading?
  - Ground truth (goodness of assignment) is hard to obtain
  - Students (graders) have noisy signals that reveal the assignment quality
  - Want to incentivize graders to truthfully reveal the signals

	Signal	
	G	B
Good	80%	20%
Bad	40%	60%

Common prior:
80% of the assignments are “good”

- Randomly pick two students to grade the same assignment
  - Simply rewarding “the same report” is probably not a good idea
    - Every grader can just give high score for every assignment
  - How should we do it?

Information Design with Bayesian Persuasion

- A company wants to hire interns from our class and asks me for recommendation letters

- Assumption
  - 30% of students are “good” -> meet their requirement
  - They don’t know who are good but I know

- How do I write letters to maximize the number of students getting hired?