Incentives in Crowdsourcing Markets with Heterogeneous Tasks

Gagan Goel, Google research
Afshin Nikzad, Stanford University
Adish Singla, ETH
Market Mechanisms for Crowdsourcing

Our model for a crowdsourcing market involves

- Heterogeneous Tasks
- Workers with different skill sets

Goal:
Efficient assignment of Tasks to Workers
A Real-World Experiment: Market Mechanisms for Crowdsourcing

The Wikipedia experiment:
- Tasks: wiki page translations
- Workers: Translators
- A limited budget for hiring workers

Goal:
Maximize total utility obtained from the pages that get translated

In the end, we apply our solution on this market
Overview of the Model

- Each worker has a cost
- Each task has a utility
- A bipartite graph describes the skill sets of workers
The Mechanism Design Problem: Example

- We do not assume that the workers’ costs are known.
- Rather, we design a mechanism to which they report their costs.
The Mechanism Design Problem

Given:

- Budget $B$
- A bipartite graph $G(W,T)$
- Each task has a publicly known utility
- Each worker has a private cost

Design a mechanism:

- Workers report their bid (costs) to the mechanism
- The mechanism assigns them to tasks
The Mechanism Design Problem

The mechanism must be:

● Truthful
  ○ No worker has incentive to report a fake cost

● Efficient
  ○ Ratio of the collected utility to the optimal utility
Our Mechanism
(a reverse auction)
Key Concept

- *buck-per-bang* rate $r$
  - Pay $r \cdot u$ to a worker for doing a task with utility $u$
1. Fix a buck-per-bang rate $r$

2. Prune the graph $G$
   - remove an edge $(w,t)$ if $c_w > r u_t$

3. Generate an allocation in the new graph

4. Compute the prices (based on $r$)

5. Check for budget feasibility
Basic Definitions

- Fix an ordering on the agents, namely $\sigma$
- The tentative task assigned to $i$ is $T(i)$
The Mechanism

1. \( r \leftarrow \infty \)

2. For \( i = 1 \) to \( |W| \)

   \[ T(\sigma(i)) = \text{task with the highest utility} \]
   that is doable by \( \sigma(i) \)

3. Payments are possible with rate \( r \)?
   a. No: decrease \( r \) and repeat
   b. Yes: stop and pay.
Results

- The mechanism is oneway-truthful
- It is also truthful under a different payment rule
  - Pay each worker her critical bid
- It is Efficient
  - 3-approximation in large markets
- By choosing $\sigma$ uniformly at random
  - The approximation ratio becomes $\frac{2e - 1}{e - 1} \approx 2.58$
  - The mechanism is truthful in large markets
Wikipedia translation project: MTurk Study

Distribution of bids

Top languages, topics and tasks

Worker’s profile
Wikipedia translation project: Results

- **Overall utility**
  - Graph showing utility (page views) versus budget ($).
  - Lines for different mechanisms:
    - Untruthful-Greedy
    - Truthful-UniformRate
    - Untruthful-Random
    - Truthful-MeanPrice

- **Utility per language**
  - Graph showing per language utility (page views) versus budget ($).
  - Lines for languages:
    - German
    - French
    - Russian
    - Arabic