Task routing

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Designing HIT

Input → Task routing → Task design → Task aggregation → Output

Today
Task routing

Problems:
• Distributing to many non-expert and aggregate outputs to approximate expert answers.
• Identifying expert in a crowd.
• Trust users based on their (estimated) expertise.

Methods:
• Passive: assign randomly and discard un-trusted output afterward,
• Active: Assign HIT to the most suited workers.
Expert vs. non-expert

**Expert:**
- Generate better, faster and more accurate solutions,
- Can identify deeper structures in a problem,
- Efficient information retrieval.

**Non-expert:**
- Bigger force task,
- Promote learning and assign difficult task to non-experts.
Examples

• Paying Turkers to translate a long text,
• Hiring a small team of worker to evaluate documents,
• Find an expert to check a mathematical proof,
• Getting gamers to make an alignment with Phylo,
• Asking someone to find a recycling box near their current location.
Which factors influence the routing strategy?

• Human-computer interactions
  o Assign task iff a task is available,
  o Always assign task,
  o Seek experts and assign them a task,

• Scale of the system
  o How many tasks?
  o How many potential workers?

• Characterizing the crowd
  o Duration of human-computer interaction,
  o Can we estimate the reliability of the workers?
Push vs. Pull

**Push**: System controls the distribution of tasks. The worker is *passive*.

**Pull**: Workers can browse, visualize & search data. The workers are *active*. 
Push approach: Matching

Workers have strict preferences. Solve the stable marriage problem (Gale-Shapley algorithm).

Round: 3
Worker’s expertise is known (or estimated).

A **coalition** is a group of agents which cooperate in order to achieve a common task.

*(Coalition Problem).* Given \( \langle A, H, T \rangle \), *the coalition problem is to assign tasks* \( t \in T \) *to coalitions of agents* \( C \subseteq A \) *such that the total utility is maximized and the precedence order is respected.*

*(Shahaf & Horvitz, 2010)*
Single task scenario

Allocation based on estimate of worker’s attributes:
• System has knowledge of worker’s skills.
• Participants associated with cost and utility (e.g. location)

In both case, routing is an NP-hard problems (coverage problems) but can be approximated using greedy algorithms

**Problem:** How to perform allocation if no one has the skills to perform a specific task?

(Shahaf & Horvitz, 2010)
Workers are vertices and allocations of tasks are hyperedges. Color indicates the task and weight the expected reward.

**Objective:** find a maximum value matching in the graph such that only one edge of each color is used.

**Result:** A greedy algorithm yields a $\frac{1}{2}$-approximation.

(Shahaf & Horvitz, 2010)
Multi-commodity flow problem on $G = (V, E, w)$.

- $s \in V$ represents a language.
- Directed edges are resources,
- Edge’s weight $w$ is the degree of competence,
- Source & sink nodes represent the source & target language.

NP-complete problem, typically solved with a fully polynomial time approximation scheme and Linear Programming.

(Shahaf & Horvitz, 2010)
Push approach: Inference

How to proceed when worker’s expertise, motivation & cost are unknown?

• Decision theoretic model
• Exploration-exploitation tradeoff
Decision theoretic model

- Probability/cost $C(w)$ of a worker to achieve a task
- Utility $U(w)$ of the task (E.g. quality, worker’s satisfaction)

**Goal:** maximize the expected utility.

**Technique:** Proactive learning

(Donmez & Carbonell, 2008) 2 step algorithm:

1. *Discovery:* Probing worker’s characteristics
2. *Task assignment:* Choose iteratively task-worker pair maximizing the cost-benefit trade-off.
Exploration-exploitation tradeoff

At every step the algorithm can explore (information gathering) or exploit (i.e. assign a task).

(Donmez et al., 2009)

- For each action $a_i$ we record the number of time it has been performed $n_i$ and its success rate $w_i$.
- At each step, we estimate the confidence interval of the success rate and choose the one with highest upper bound.

Remark: Time changes (experience, fatigue) can be integrated.
Pull approach

Workers tend to choose tasks in which they have the most expertise, interest & understanding.

+ More effective on platform with high turn-over.
- Coverage & completion time.

(Law et al., 2011)
Search & visualization

Mechanical Turk UI is very primitive. Users constantly refresh the web page to find most recent HITs.

Better classification of HIT using Web Ontology Language.

(Chilton et al., 2010)
Task recommendation

Netflix, Amazon, etc.

**Objective:** Match users to set of objects.
Task recommendation

- **Content based methods**: Detect similarities between user profile & item characteristics.

- **Collaborative filtering methods**: Use preferences (i.e. ratings) to infer similarities between individuals.

**Applications**: Wikipedia.

**Challenges in human-computation systems**:  
- It must satisfy the requester’s needs as well,  
- Tasks are typically non persistent.
Peer-routing

Workers can:
1. Accept or reject a task,
2. Recommend another worker,

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- Ranking of workers replace ranking of tasks,
- Develop UI to search skilled workers.

(MacDonald & Ounis, 2006)
Evaluation of routing

Primary criteria to evaluate the quality of a routing strategy:

- Accuracy
- Discovery
- Efficiency
- Worker motivation
References

Human Computation
Edith Law, Luis von Ahn
Morgan & Claypool Publishers