KYOTO UNIVERSITY

Crowd-ordering

Toshiko Matsui (Univ. Tokyo), Yukino Baba (NII)
Toshihiro Kamishima (AIST), Hisashi Kashima (Kyoto Univ.)

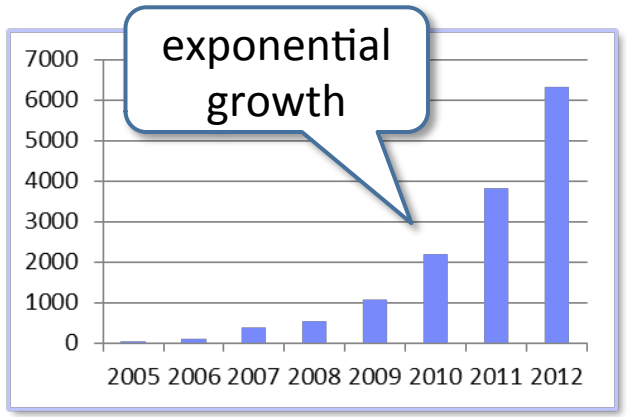
DEPARTMENT OF INTELLIGENCE SCIENCE AND TECHNOLOGY

Crowdordering:
Crowdsourcing quality control method for item ordering

- Crowdsourcing quality control problem
- Quality control problem for item ordering tasks
- We propose a quality control method:
  - Generative model of crowdsourced orderings
  - Efficient iterative algorithm
- Experiments using word ordering tasks and sentence ordering tasks

Rise of crowdsourcing: On-demand access to massive on-line labor

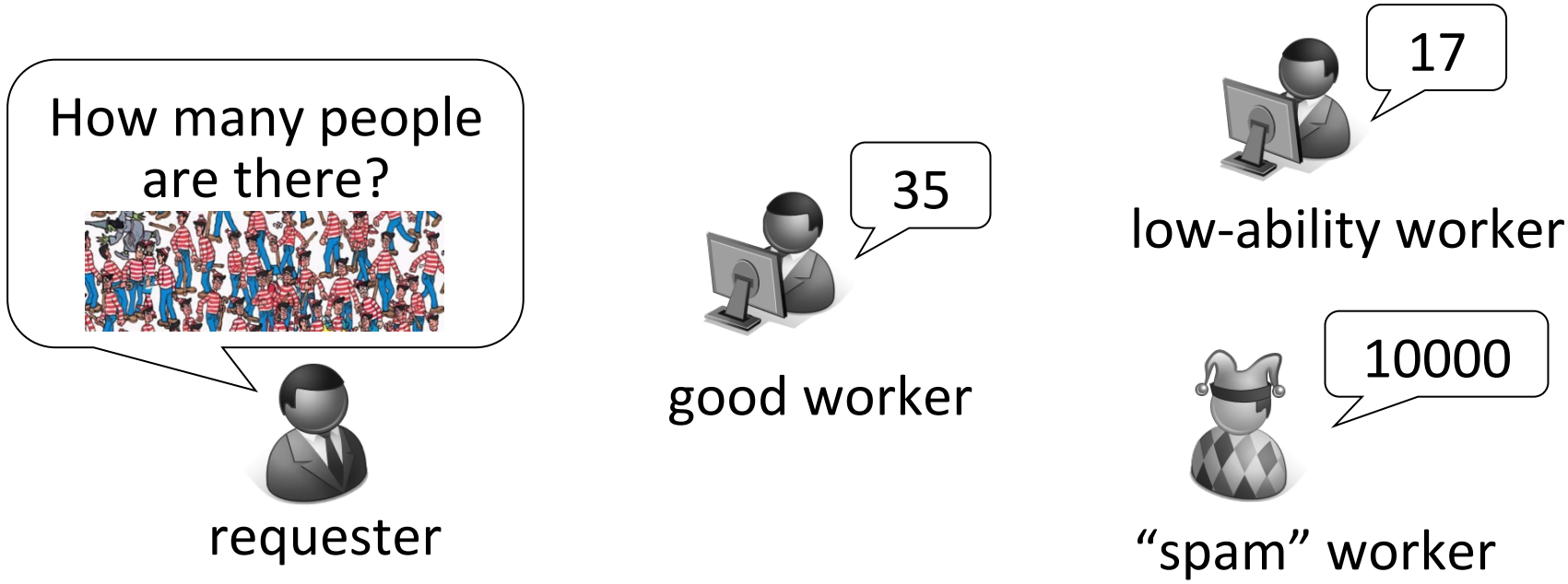
- Crowdsourcing: Outsourcing human-intelligence tasks to a large group of unspecified people via Internet
  - Emergence of online crowd-labor marketplaces
  - Popular use in computer science: image classification, speech recognition, translation, …



#papers related to crowdsourcing

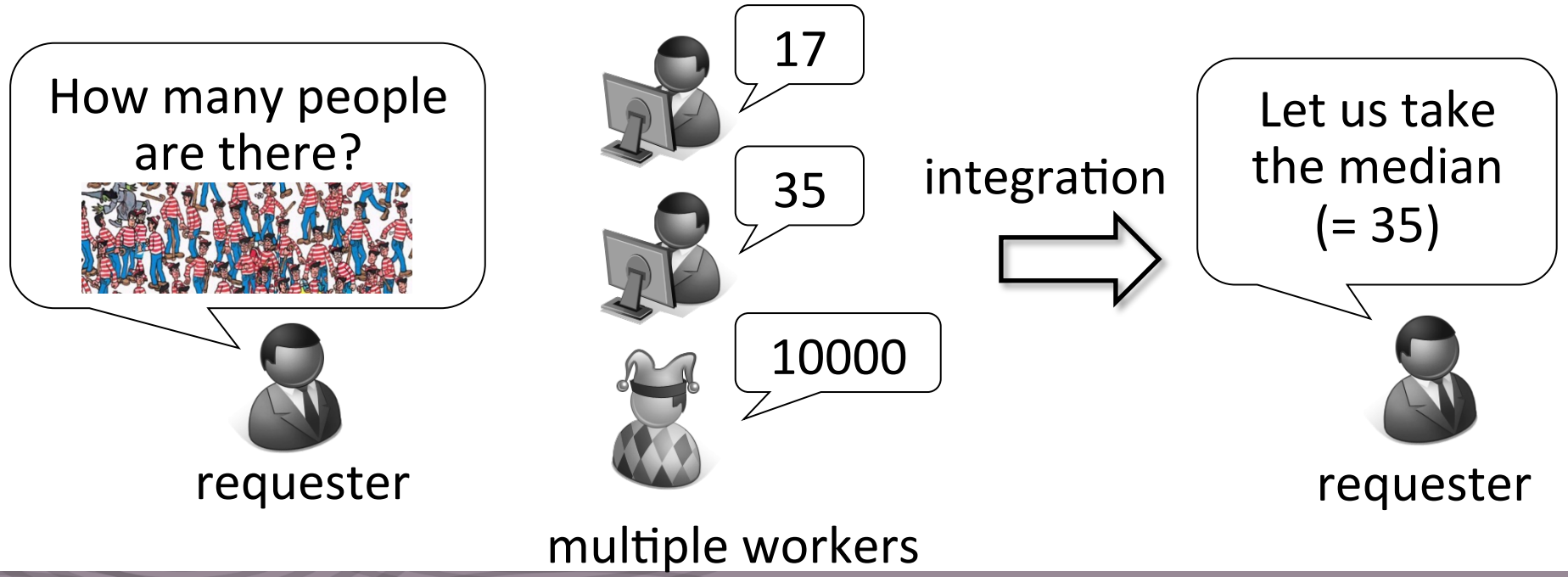
Quality problem of crowdsourcing: Uneven quality

- Wide variance in quality of results:
  - depending on workers' abilities and diligence
  - Existence of "spam" workers



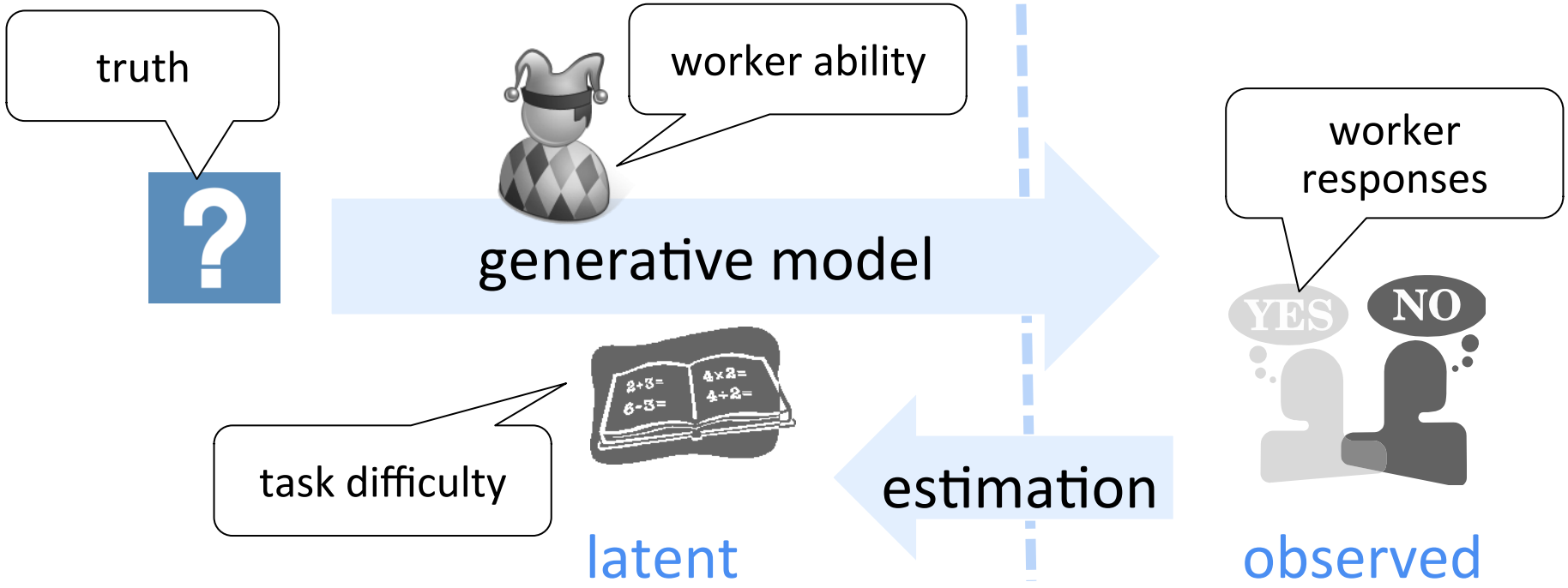
Crowdsourcing quality control: Redundancy is the key

- A solution: Introducing redundancies
  1. Multiple workers for one task
  2. Integration the results (e.g. voting / averaging)



Statistical approaches to crowdsourcing quality control: Generative modeling of observed results

- Various generative probabilistic models:
  - Consider factors like worker ability and task difficulty
  - Statistical inference of truths

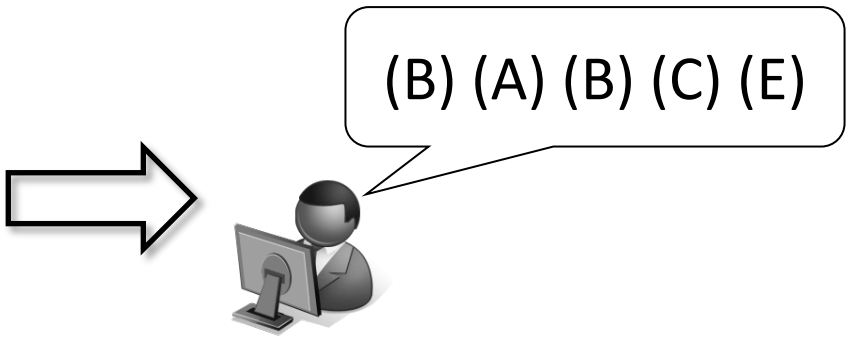


Our focus in this paper: Item ordering tasks

- Item ordering tasks: asking workers to arrange multiple items in the correct order
  - ranking of web search results
  - ordering of items in a to-do list by their dependencies

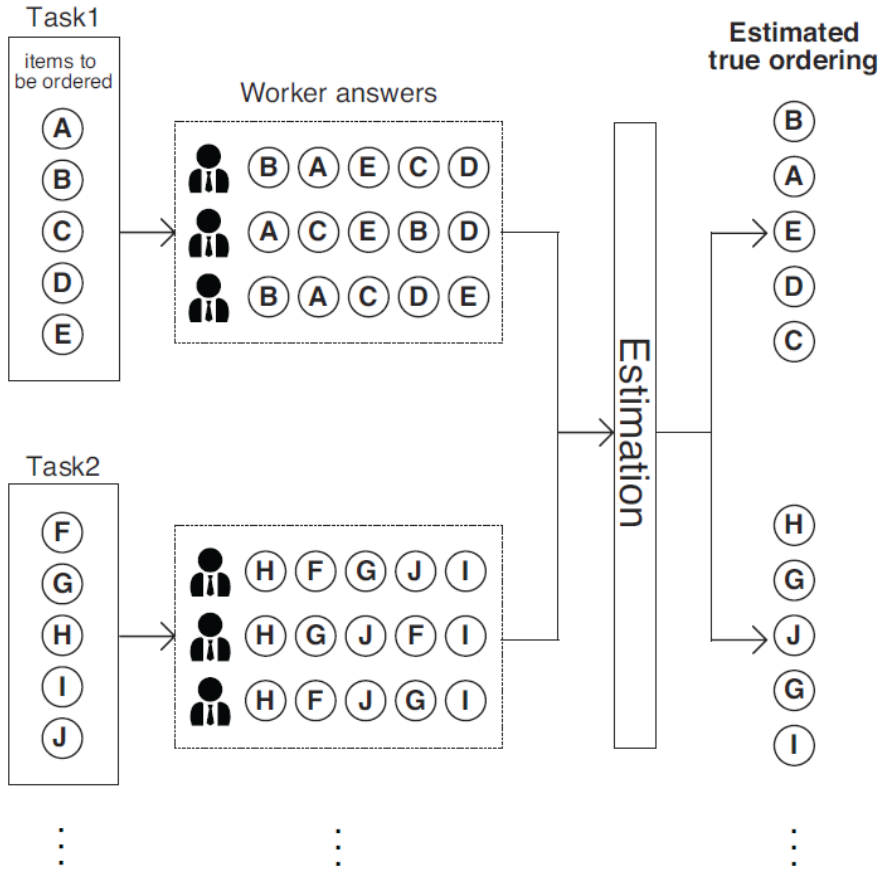
Word Ordering

Please arrange the words from (A) to (E) in the correct order so that the sentence makes sense.
Don't be so **(A) to (B) naive (C) everything (D) believe (E) as** the politicians say.



Quality control problem for item ordering tasks: Integration of crowdsourced orderings

- Input: Worker answers for each task
- Outputs: Estimated true ordering for each task



Generative model of crowdsourced orderings: Multi-worker extension of a distance-based model

- Distance-based model of orders:
  - Probability of a particular ordering depends on the distance from some "mode" ordering
    - Spearman distance d between two orderings
- Multi-worker extension of the distance-based model
  - Ability $\lambda^{(k)}$ of worker k controls concentration to the mode

$$\Pr[\tilde{\boldsymbol{\pi}} \mid \boldsymbol{\pi}, \lambda^{(k)}] = \frac{1}{Z(\lambda^{(k)})} \exp\left(-\lambda^{(k)} d(\tilde{\boldsymbol{\pi}}, \boldsymbol{\pi})\right)$$

distance between two orderings

ability of worker k

mode ordering

Estimation:
Maximum likelihood estimation

- Objective function w.r.t.
  - $\{\lambda^{(k)}\}$: worker ability parameters
  - $\{\pi_i\}$: true orderings (mode orderings)

$$L(\{\lambda^{(k)}\}_k, \{\boldsymbol{\pi}_i\}_i) = \sum_k \sum_{i \in \mathcal{I}^{(k)}} \log \frac{1}{Z(\lambda^{(k)})} \exp\left(-\lambda^{(k)} d(\boldsymbol{\pi}_i^{(k)}, \boldsymbol{\pi}_i)\right)$$

$$= -\sum_k \sum_{i \in \mathcal{I}^{(k)}} \left\{ \lambda^{(k)} d(\boldsymbol{\pi}_i^{(k)}, \boldsymbol{\pi}_i) + \log \sum_{\tilde{\boldsymbol{\pi}}} \exp\left(-\lambda^{(k)} d(\tilde{\boldsymbol{\pi}}, \boldsymbol{\pi}_i)\right) \right\}$$

Algorithm:
Iterative algorithm

- Iterative algorithm consisting of two steps:
  1. Optimization wrt worker ability parameters $\{\,^{(k)}\}$
     - Each $\,^{(k)}$ can be optimized independently
     - Simple gradient-based method only with one variable
  2. Optimization wrt true orderings $\{¼_i\}$
     - Mode ordering can be easily found if we employ Spearman distance
     - Optimal solution is guaranteed

item1 item2 item3
rank vector A = (1 , 3, 2)

↕ Euclidean d

rank vector B = (3 , 1, 2)

Experiments:
Word ordering tasks and sentence ordering task

- Posted two benchmark tasks to Lancers.jp
  - Word ordering
  - Sentence ordering

Word Ordering

Please arrange the words from (A) to (E) in the correct order so that the sentence makes sense.
Don't be so **(A) to (B) naive (C) everything (D) believe (E) as** the politicians say.

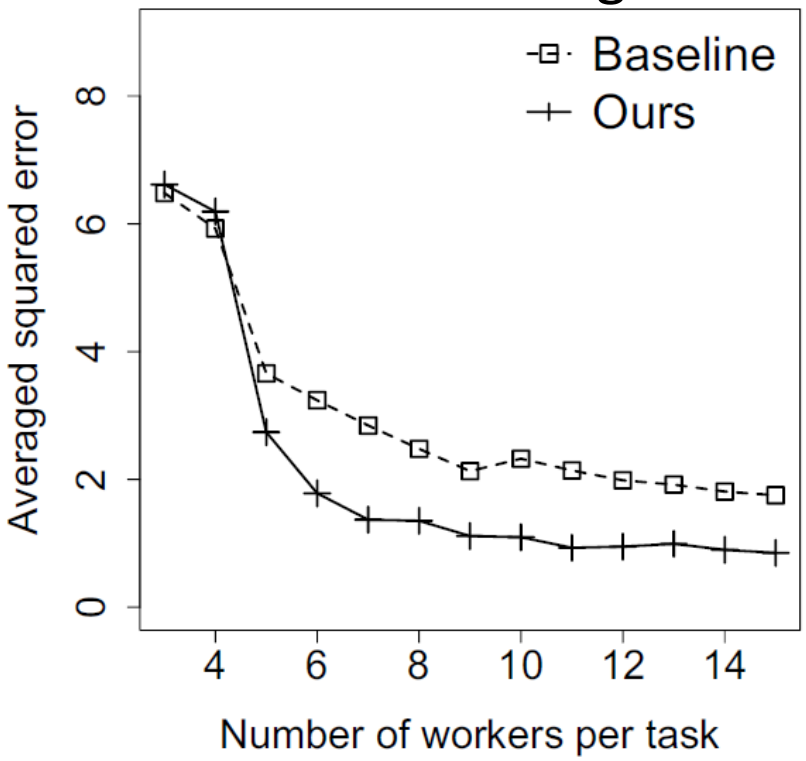
Sentence Ordering

Please arrange the following five sentences so that the whole passage makes sense.
A. It' s not outsourcing. **B.** Hobbyists, part-timers, and dabblers suddenly have a market for their efforts, as smart companies in industries as disparate as pharmaceuticals and television discover ways to tap the latent talent of the crowd. **C.** The labor isn' t always free, but it costs a lot less than paying traditional employees. **D.** Technological advances in everything from product design software to digital video cameras are breaking down the cost barriers that once separated amateurs from professionals. **E.** It' s crowdsourcing.

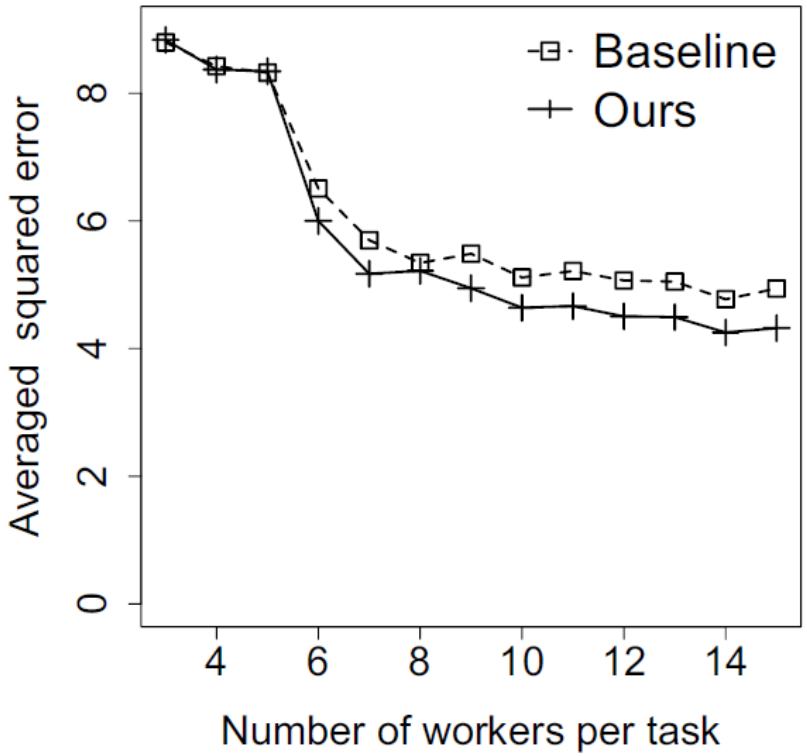
Result 1:
Worker ability modeling improved performance

- Incorporating worker ability into model improved accuracy of integrated results

word ordering



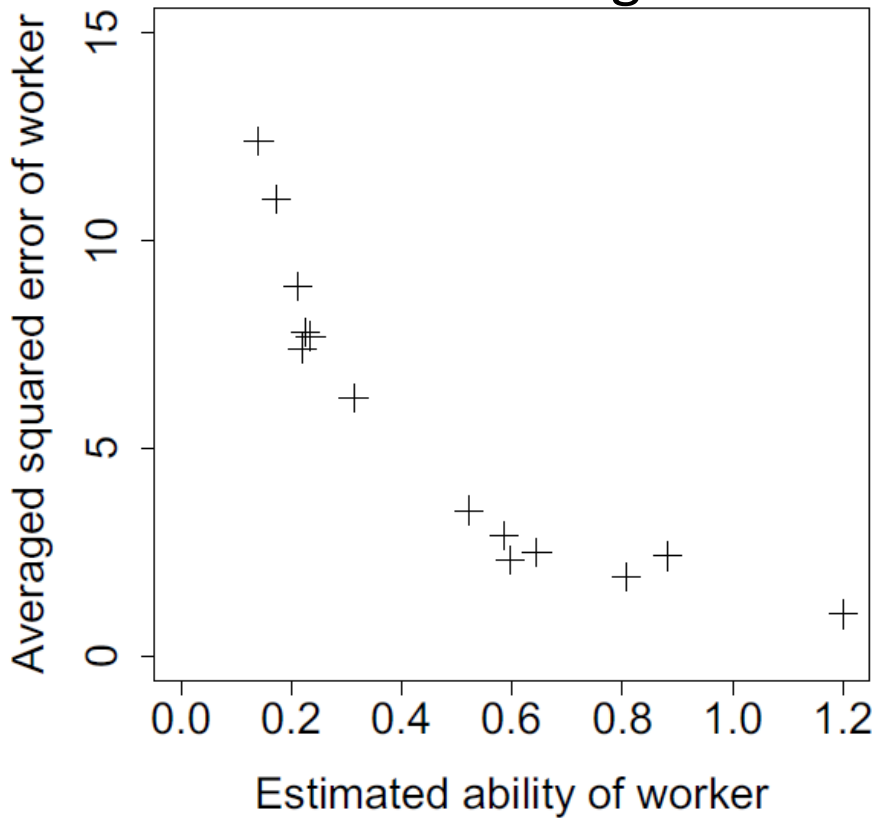
sentence ordering



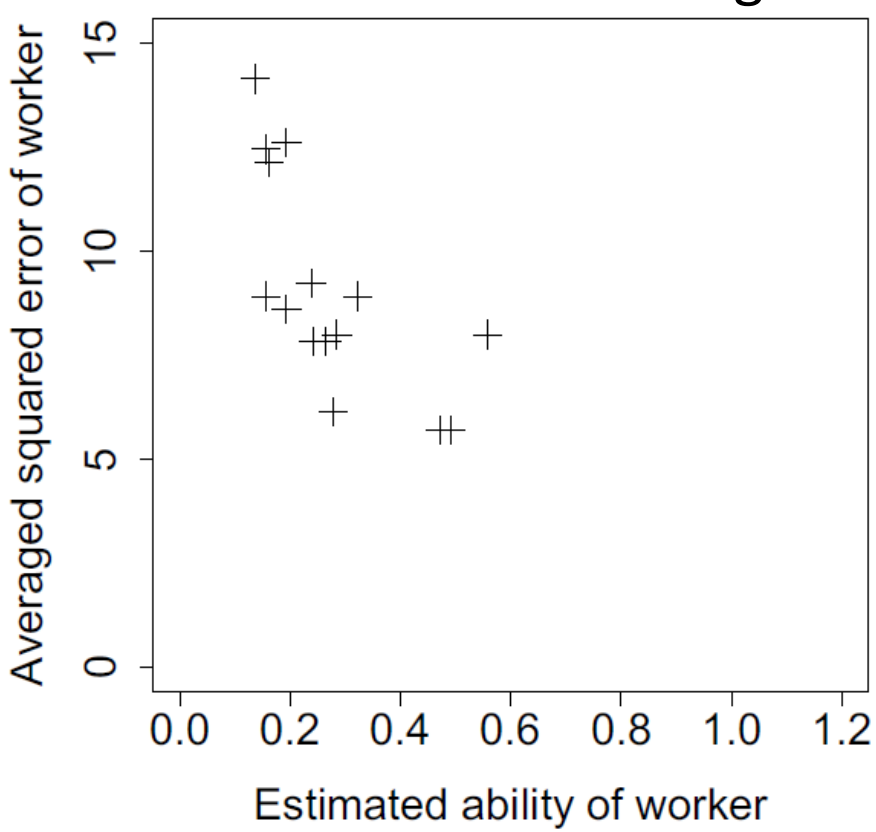
Result 2:
Worker ability is well estimated

- Clear correlation between estimated worker ability and true accuracy

word ordering



sentence ordering



Conclusion: Crowdordering

- Crowdsourcing quality control
  - Integration of redundantly collected results to obtain reliable results
- Quality control problem for item ordering tasks
- We proposed a quality control method:
  - Generative model of crowdsourced orderings
  - Efficient iterative algorithm
- Promising experimental results using word ordering tasks and sentence ordering tasks

Backup