CrowdDB: Answering Queries with Crowdsourcing

Michael Franklin et al., SIGMOD'11

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CMU 15-799 course presentation

Power to the People

- Some queries cannot be easily answered by machines
  - "I.B.M.", "IBM", "I.B.N", "Big Blue", etc.
  - Which picture shows the golden bridge better?

- Human labor can be better and cheaper
  - Sometimes humans are smarter than computers
  - Ability to find new data in the open world

CrowdDB: Intuition

- Complement traditional database systems with human knowledge, whenever needed
- Leverage the best from both sides
  - Human power for comparing and finding data
  - Machine power for heavy-lifting computation
- Automate task assignment

- Crowdsourcing platform
- CrowdSQL
- User interface
- Query processing
- Evaluation

Crowdsourcing platform: AMT

- Amazon Mechanical Turk
- Basic concepts
  - HIT: Human Intelligent Task. Smallest entity of work
  - Assignment: 1 HIT replicated to N assignments
  - HIT group: similar HITs
- Mechanical Turk APIs
  - Requester: createHIT(), approve/rejectAssignment()
  - Worker: getAssignmentForHIT()

Design Considerations

- Performance and variability
  - Difference in worker productivity
- Task design and ambiguity
  - Need user-friendly interface
- Affinity and learning
  - Workers learn and become more experienced
- Relatively small worker pool
- Open vs. closed world

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CrowdSQL

- Superset of SQL
  - With minimal extension to support crowdsourcing
  - Expressive semantics
- Incomplete data
  - Crowdsource new column/record if not exist
- Subjective comparisons
  - Compare/order values

Example: Crowdsourced Column

```
CREATE TABLE Department (
    university STRING,
    name STRING,
    url CROWD STRING,
    phone STRING,
    PRIMARY KEY (university, name) );
```

```
SELECT url FROM Department WHERE
    name = "Math";
```

Example: CROWDORDER

```
CREATE TABLE picture (
    p IMAGE,
    subject STRING);
```

```
SELECT p FROM picture
WHERE subject = "Golden Gate Bridge”
ORDER BY CROWDORDER(p,
"Which picture visualizes better %subject");
```

Potential issues in CrowdSQL

- Unbounded cost and latency
  - #items to be crowdsourced is unclear
  - Can be mitigated by setting query "budget"
- Lineage
  - Track source of data to take actions
- Cleansing of crowdsourced data
  - Reduce data redundancy due to human input

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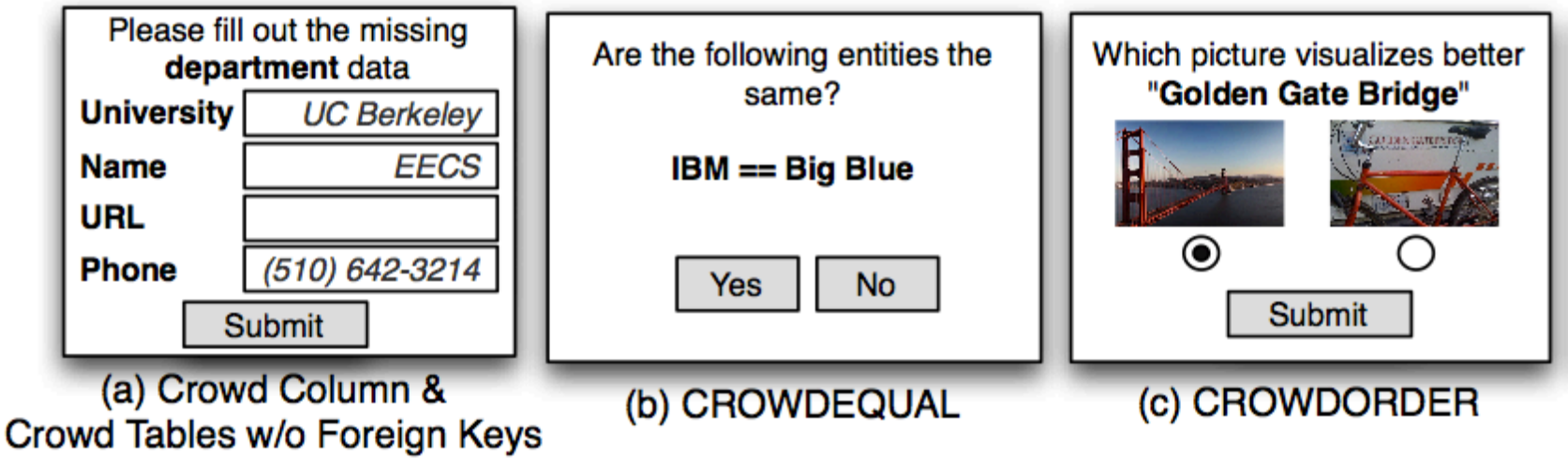
User interface

- Create templates in compile-time
- Automatically instantiate user interface templates in the runtime
- Can be edited for customized instructions

Basic Interface

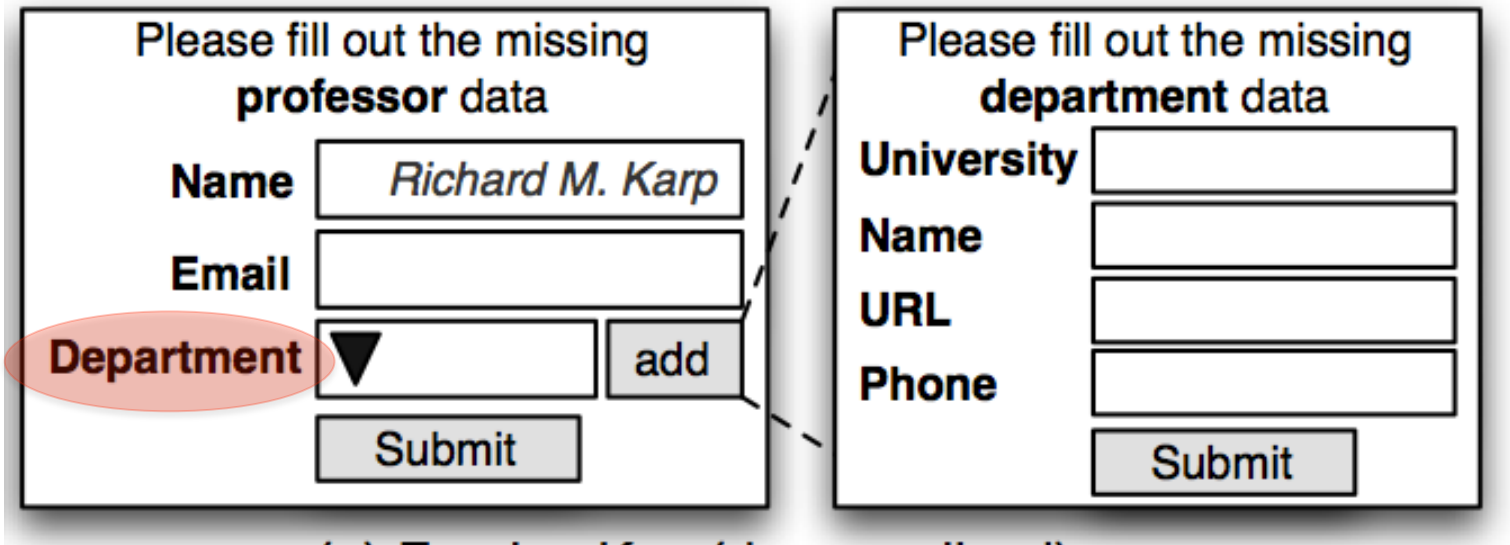


(a) Crowd Column & Crowd Tables w/o Foreign Keys

(b) CROWDEQUAL

(c) CROWDORDER

Multi-Relational Interfaces



(e) Foreign Key (denormalized)

Possible Optimizations

- Batch tuples
  - The same person for many similar tasks
- Prefetch attributes
  - Crowdsource more than needed for future use

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Query Processing

- Extended operators to support CrowdSQL
  - CrowdProbe, CrowdJoin, CrowdCompare
- Create HIT (group) using AMT APIs
- Parse crowdsourced results
  - Perform majority-based quality control
- Rule-based optimizer
  - Basic parameter setting (e.g., price, batching size)
  - Better candidate: cost-based optimizer

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Response Time

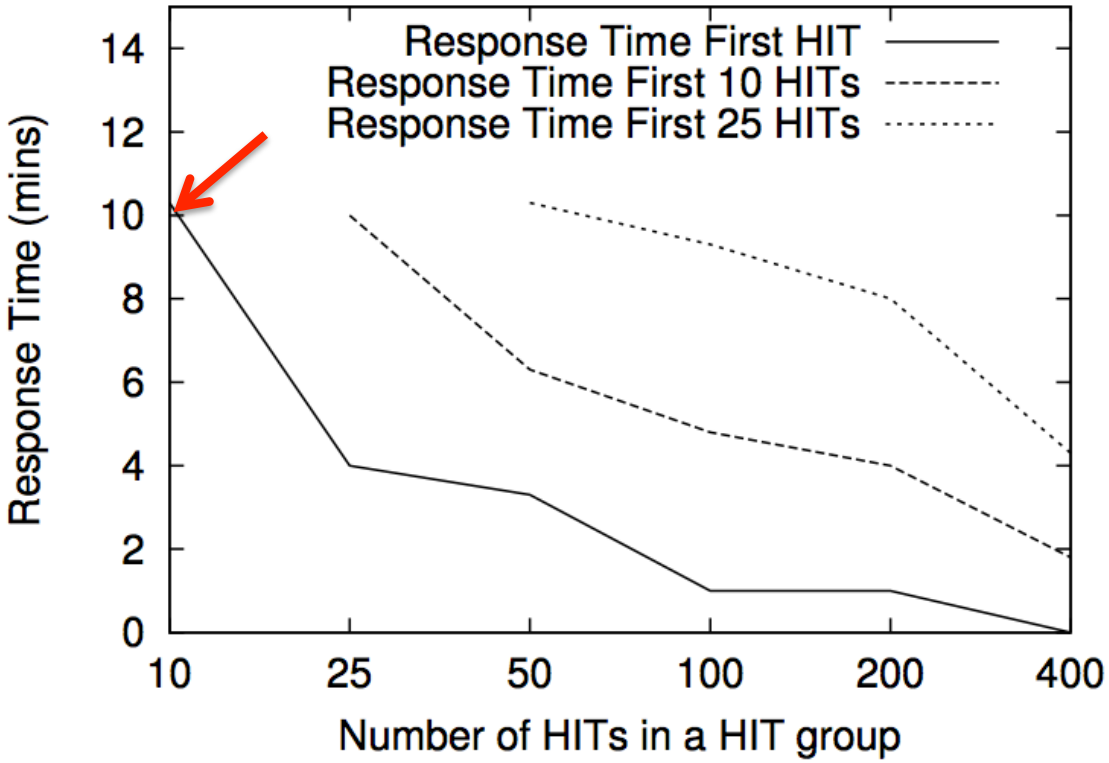

Figure 4: Response Time (min): Vary Hit Group *(1 Asgn/HIT, 1 cent Reward)*

Completion with Varied Reward

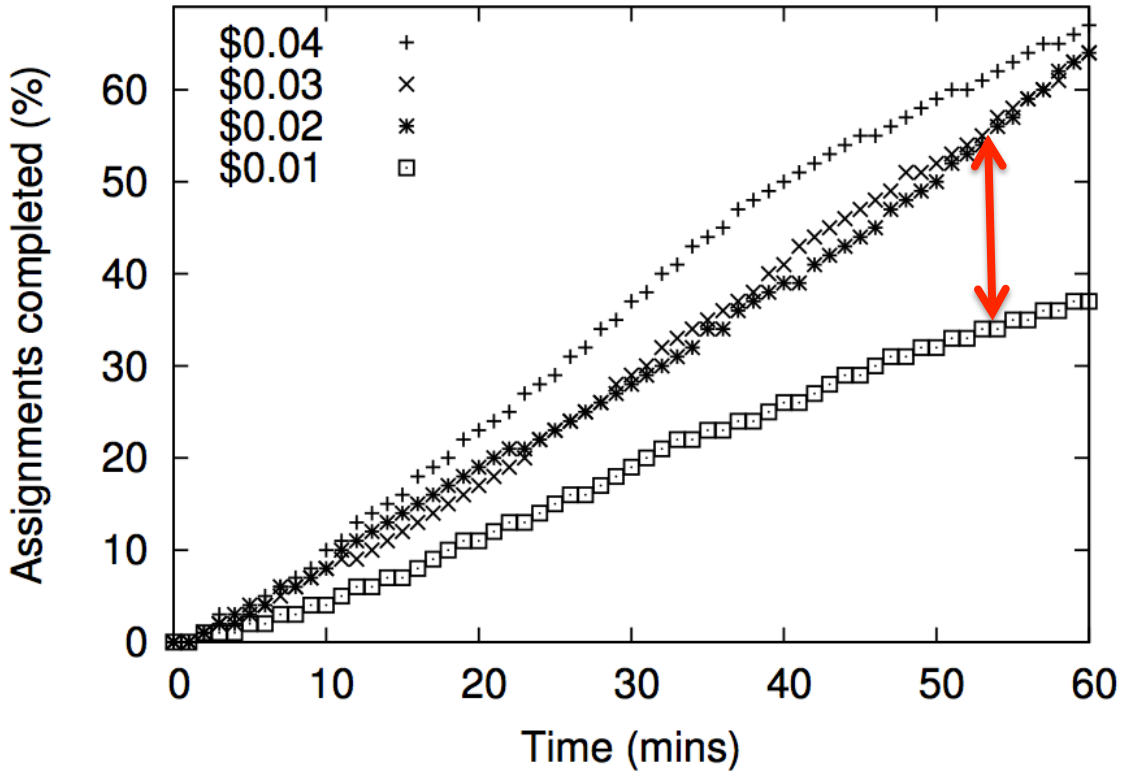

Figure 6: Completion (%): Vary Reward *(100 HITs/Group, 5 Asgn/HIT)*

HITs/Quality by Worker

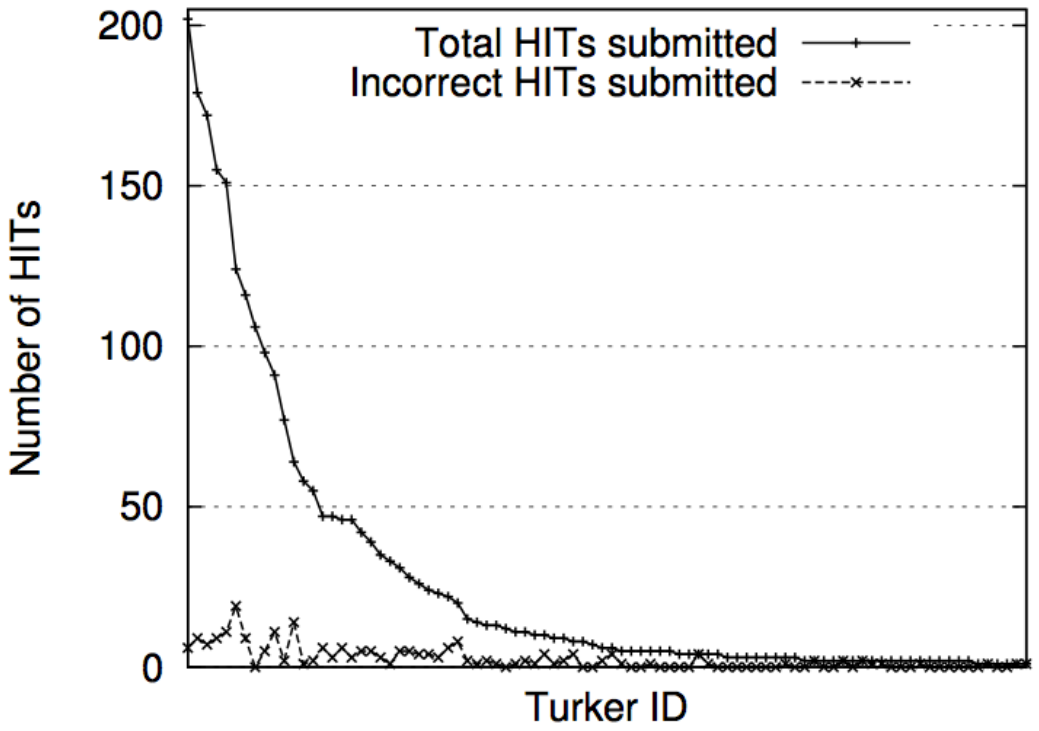

Figure 8: HITs/Quality by Worker *(Any HITs/Group, 5 Asgn/HIT, Any Reward)*

Interesting Observations

- Crowdsourcing involves long-term relationship
  - Keep the workers happy
- Interface design matters
  - A good interface improves result quality and worker efficiency
- Need of data independence
  - Free application writers from worrying about changing environment