Human Computation in Social Computing

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Topics in Social Computing

- Social Network Theory and analysis
- Large graph algorithms/ graph mining/link analysis
- Learning to rank/ personalized search
- Recommender systems/ collaborative filtering
- Social media, e.g., YouTube, Flickr, wiki, blogs, etc.
- Virtual communities, e.g., Second Life, wikipedia, etc.
- Social monetization/ computational advertising
- Policy, privacy, and secrutiy
- Opinion mining/sentiment analysis
- Human computation/social games/crowdsourcing

Social Relations

presence

crew

identity

binary

teams

social role

populations

squad

cardinal

reputation

organizations

expertise

integer

cohorts

trust

markets

ownership

real

communities

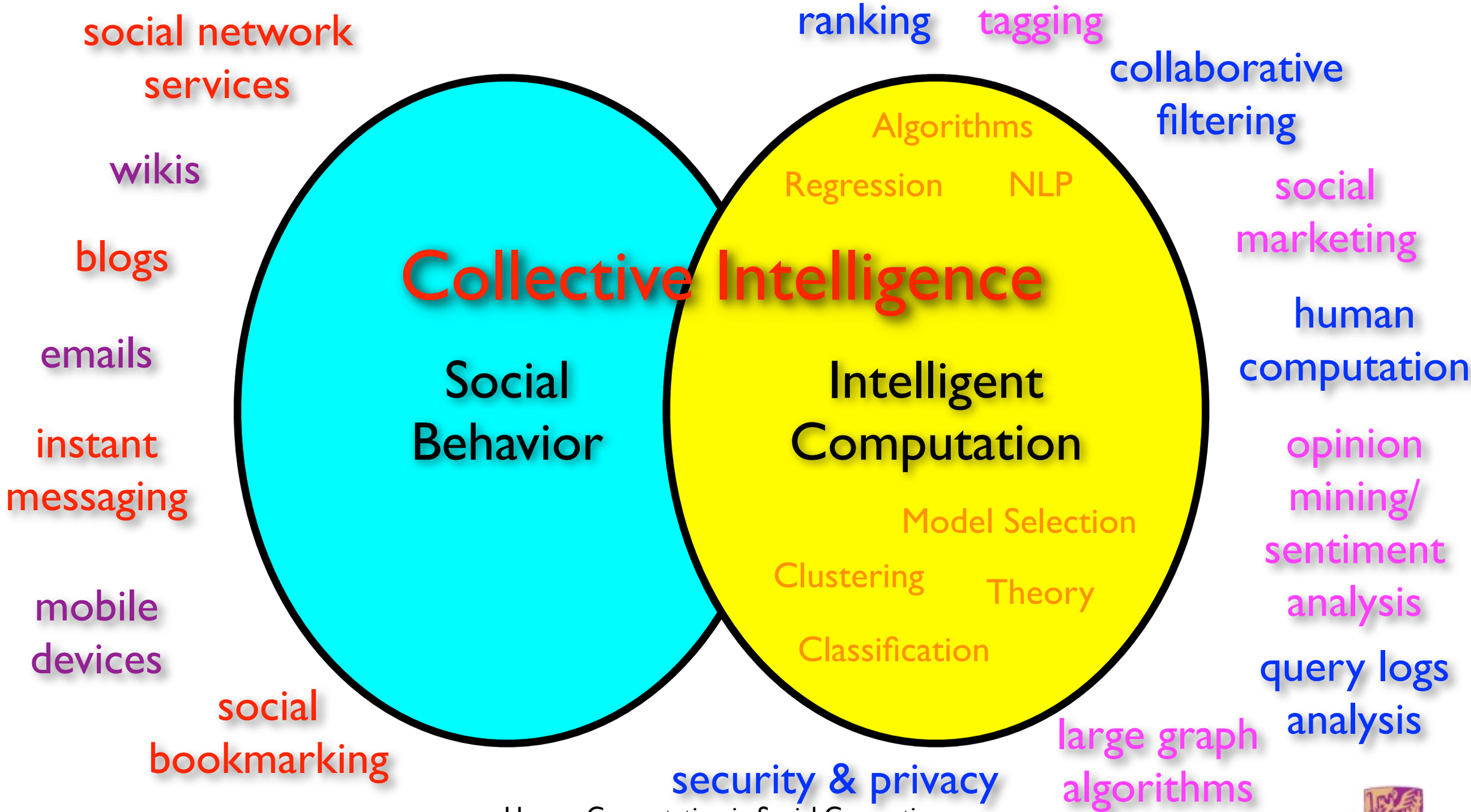
accountability

partners

knowledge

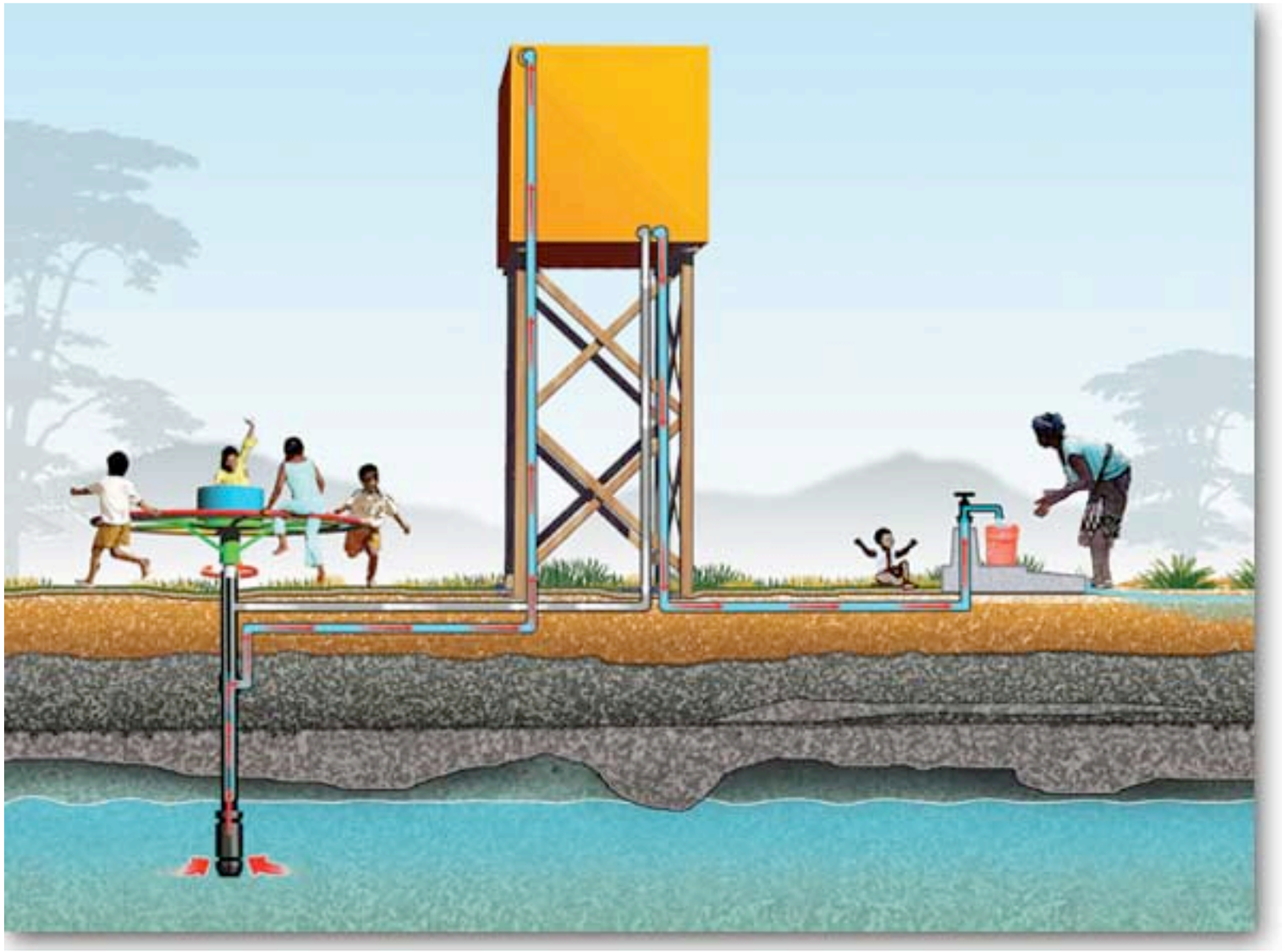
groups

Social Computing



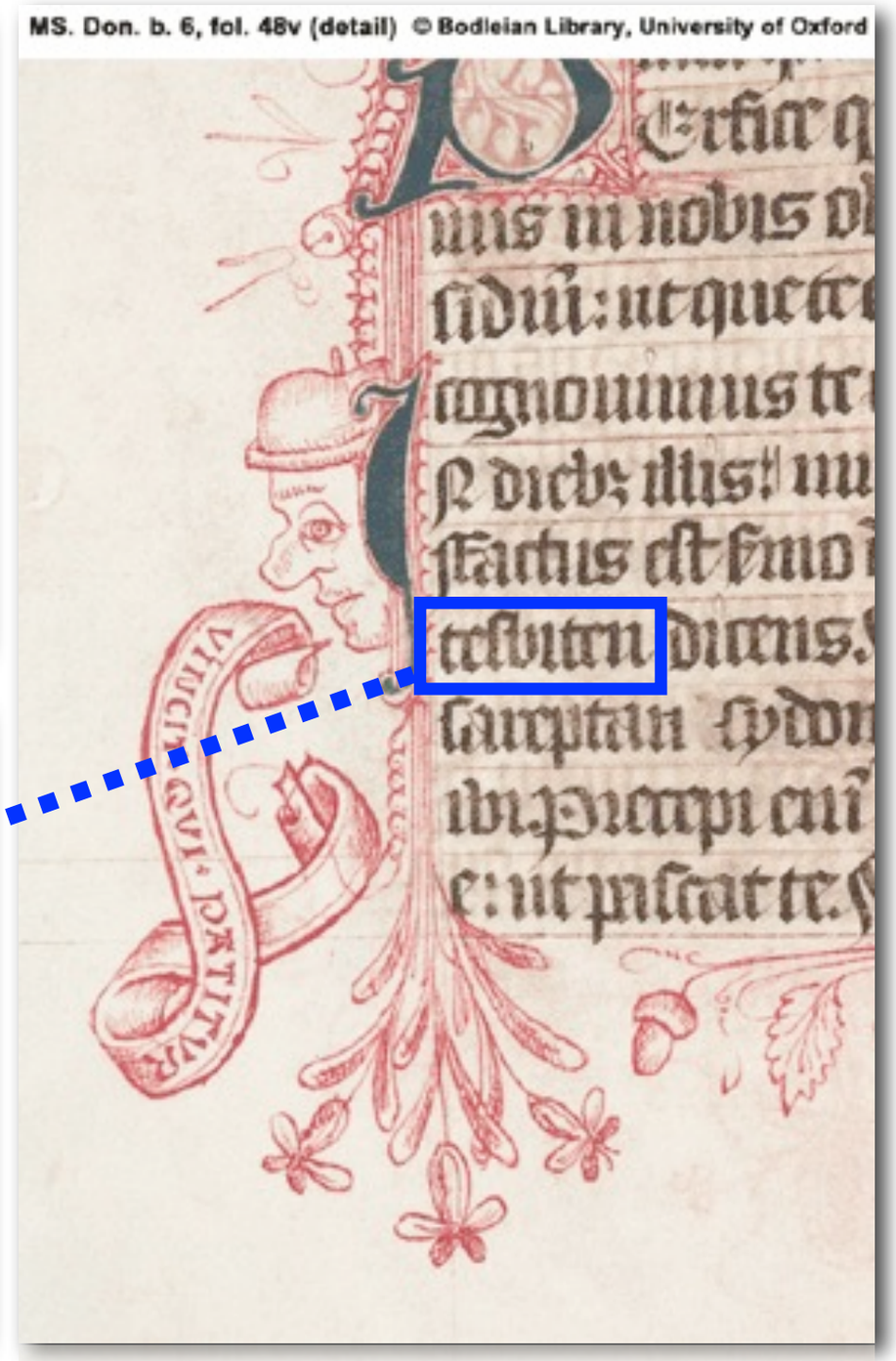
Playing/Having Fun ⟷? Work/Computation

Idea of Human Computation



- Take advantage of people's desire to be entertained and perform useful tasks as a side effect

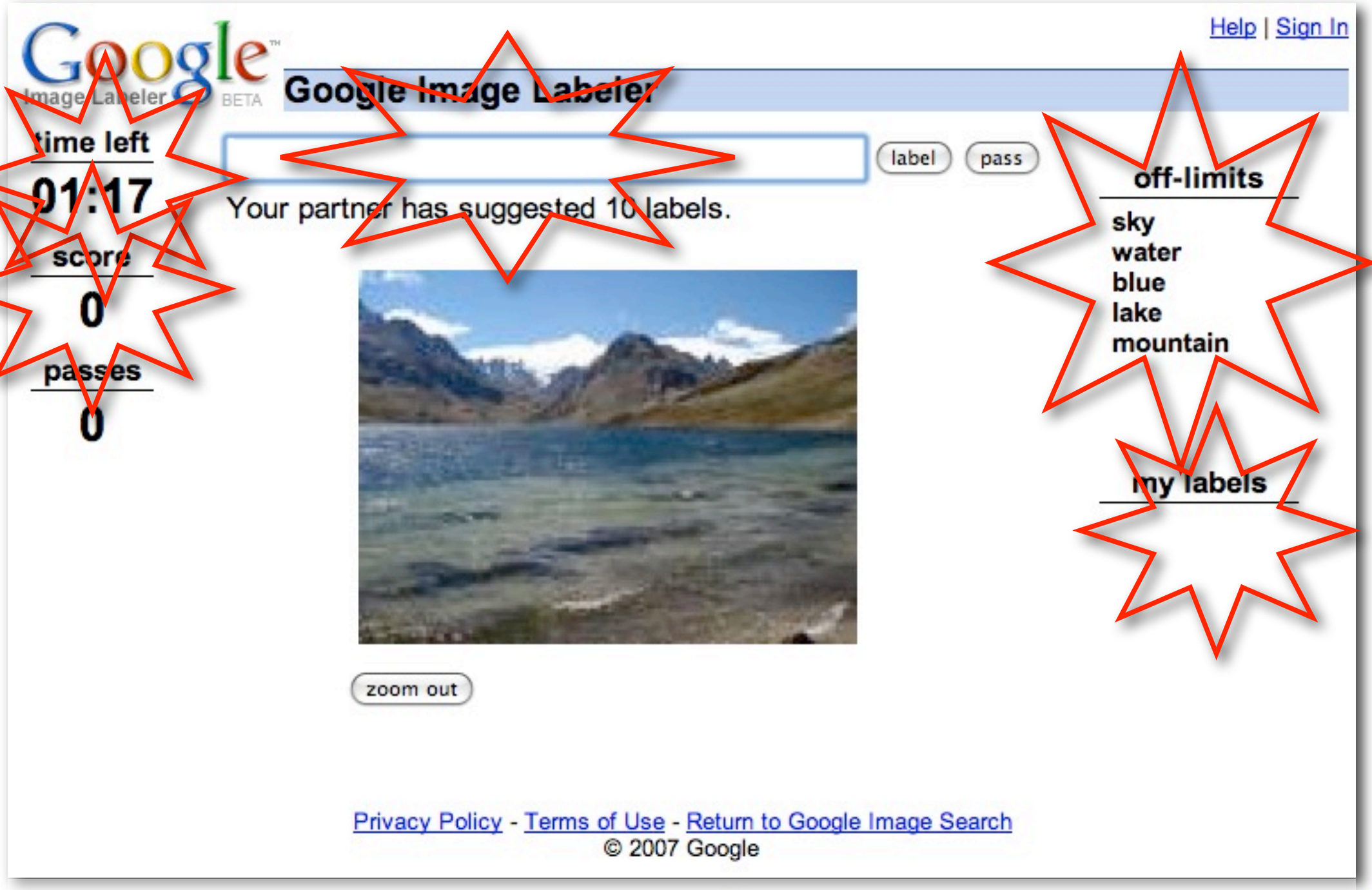
Social/Human Computation



Human Computation in Social Computing

Irwin King, First ACM Forum on Cyberspace and Social Computing (CyberSocialCom2009), November 9, 2009

Human Computation



Why Is It Important?

- Some statistics (July 2008)
  - 200,000+ players have contributed 50+ million labels.
  - Each player plays for a total of 91 minutes.
  - The throughput is about 233 labels/player/hour (i.e., one label every 15 seconds)
- Idea behind
  - Solve some problems which are difficult to be solved by computers.
  - Take advantage of people's desire to be entertained.
  - Produce useful metadata as a by-product.

Games With A Purpose

- **Matchin**
  - Image search by aesthetic value
- **Babble**
  - Translate foreign language into English
- **InTune**
  - Tags songs with description text
- **Squigl**
  - Image segmentation
- **Verbosity**
  - Database of common knowledge description

Background

- Human Computation Systems (HCS) aim to solve Artificial Intelligence (AI) problems through the human human interactions

- In order to ensure the collected information to be useful, we have to:

1. guarantee the quality of collected information
2. attract more people to contribute information

Types of HCS

- The categories of the human computation systems are:
  1. Initiatory Human Computation
  2. Distributed Human Computation
  3. Social Game-based Human Computation with volunteers or paid engineers
  4. Social Game-based Human Computation with online players

Initiatory Human Computation (1)

- Objective: To complete some tasks that are natural for humans but difficult for computers even computation power increased rapid recently

- Example (1): CAPTCHA
  - A computer generated challenge-response test
  - Objective: To distinguish humans from computers using a common sense problem

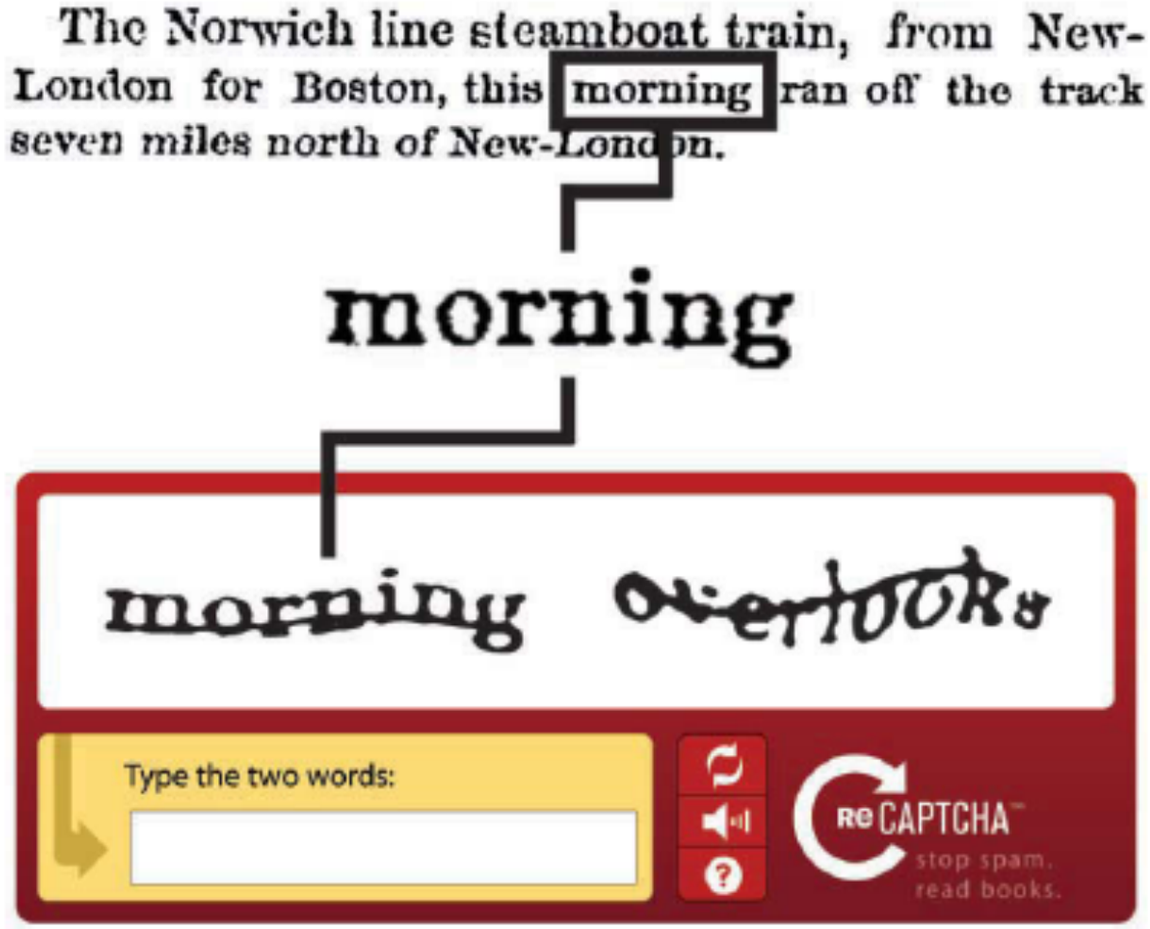
The Yahoo! CAPTCHA.

Initiatory Human Computation (2)

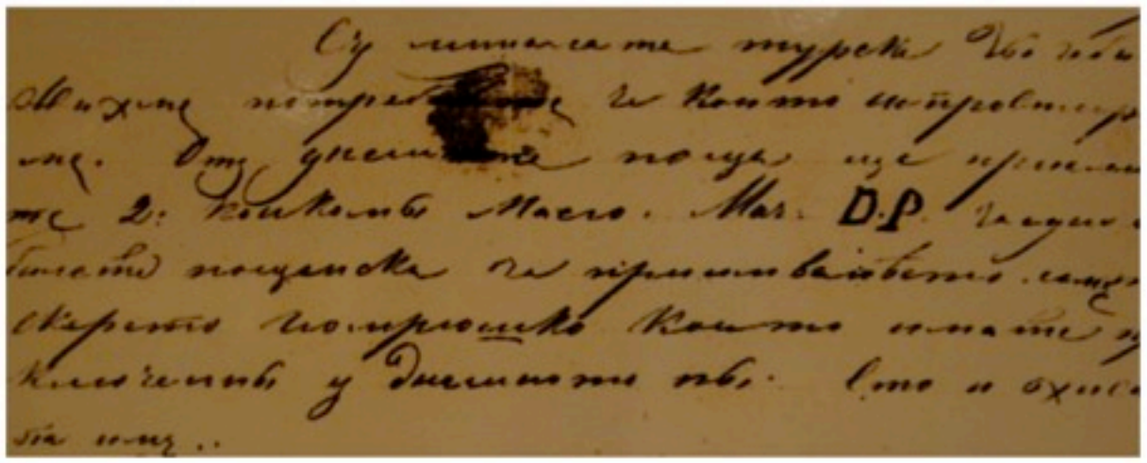
- Example (2): reCAPTCHA
  - Objective: To produce valuable common sense knowledge to improve the OCR quality in digitizing books
  - Combining two words: one identified word; and one unidentified word
  - If a user recognizes the identified word, the answer to the unidentified word is assumed to be correct

Initiatory Human Computation (3)

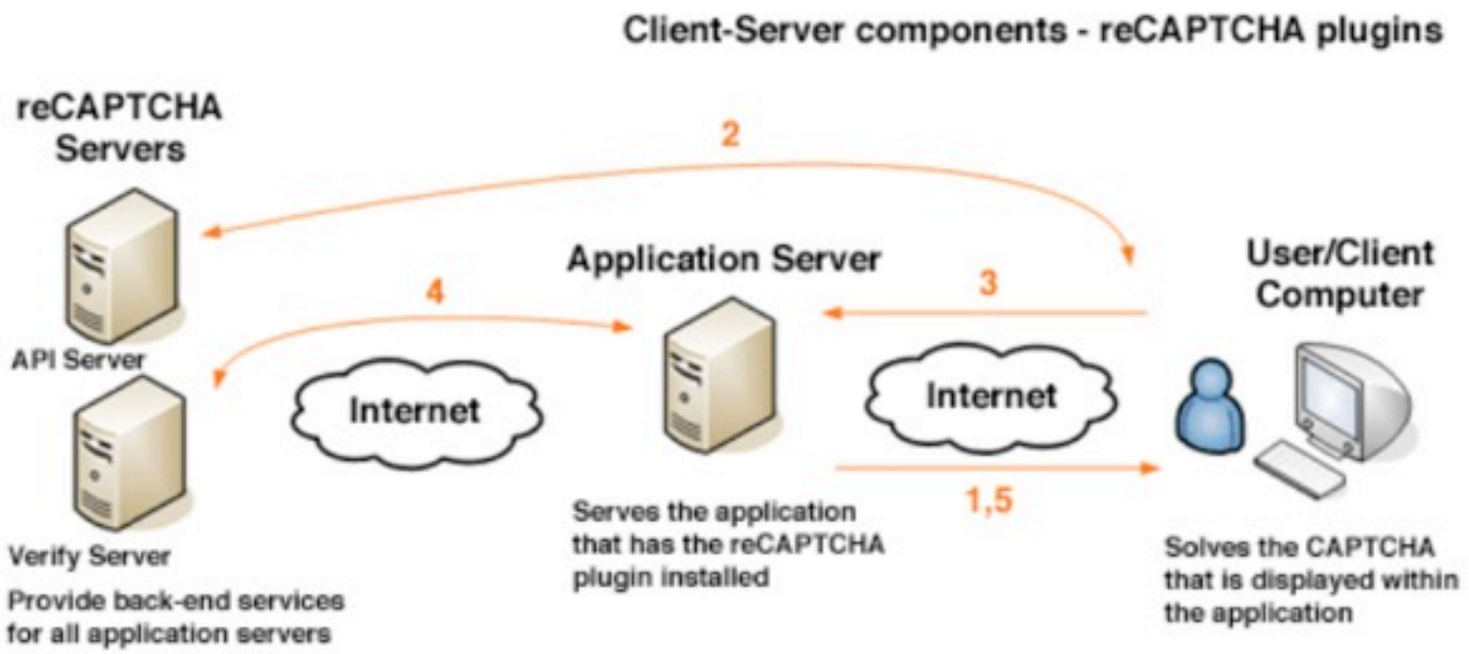
- Example (2): reCAPTCHA



reCAPTCHA

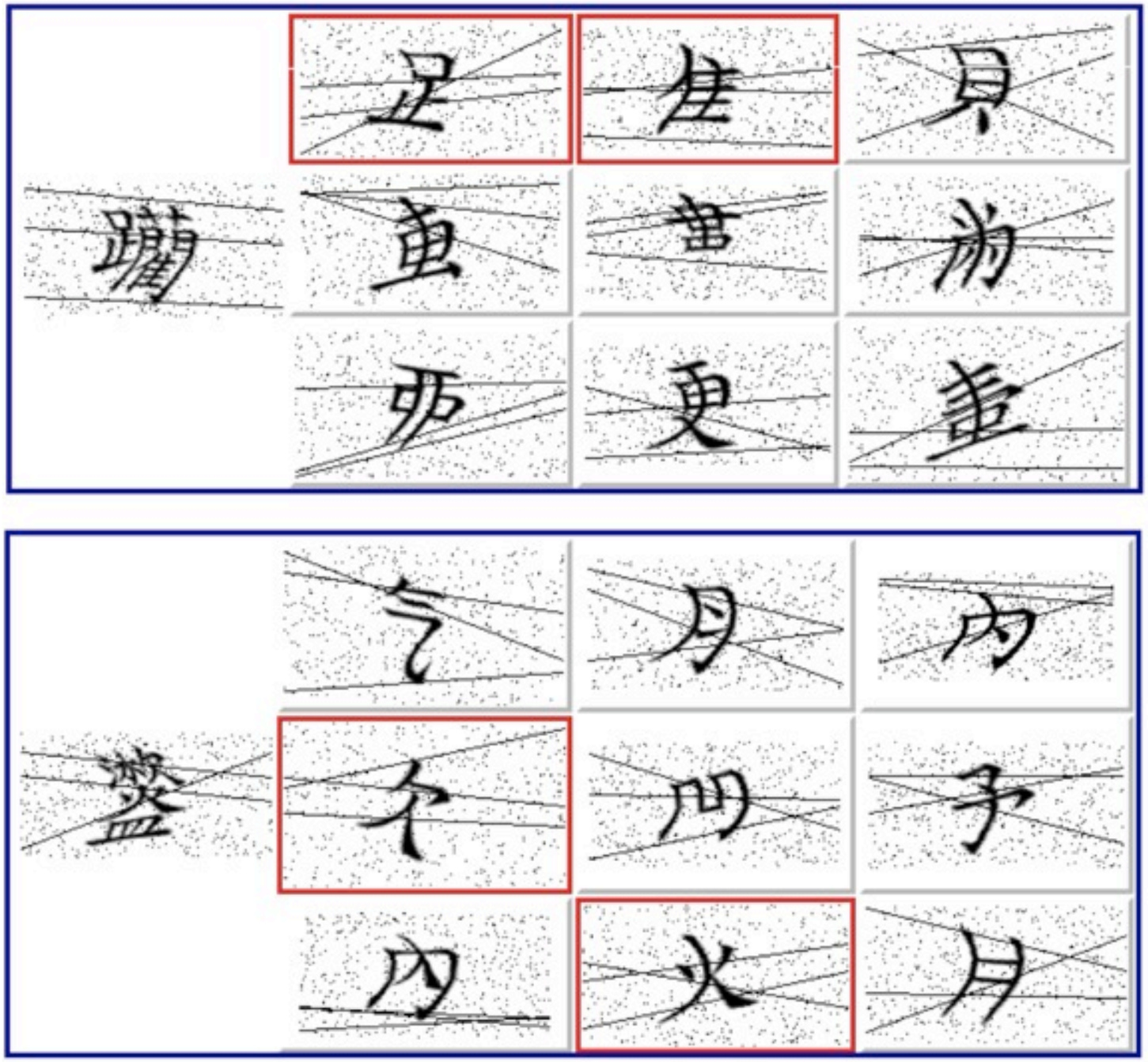



olcott
have
Type the two words:
reCAPTCHA™
stop spam.
read books.
Submit
The words above come from scanned books.
By typing them, you help to digitize old texts.


Client-Server components - reCAPTCHA plugins
reCAPTCHA Servers
API Server
Verify Server
Provide back-end services for all application servers
2
4
Internet
Application Server
Serves the application that has the reCAPTCHA plugin installed
3
Internet
1,5
User/Client Computer
Solves the CAPTCHA that is displayed within the application

Chinese CAPTCHA

Ling-Jyh Chen, Institute of Information Science, Academia Sinica, Taipei, Taiwan

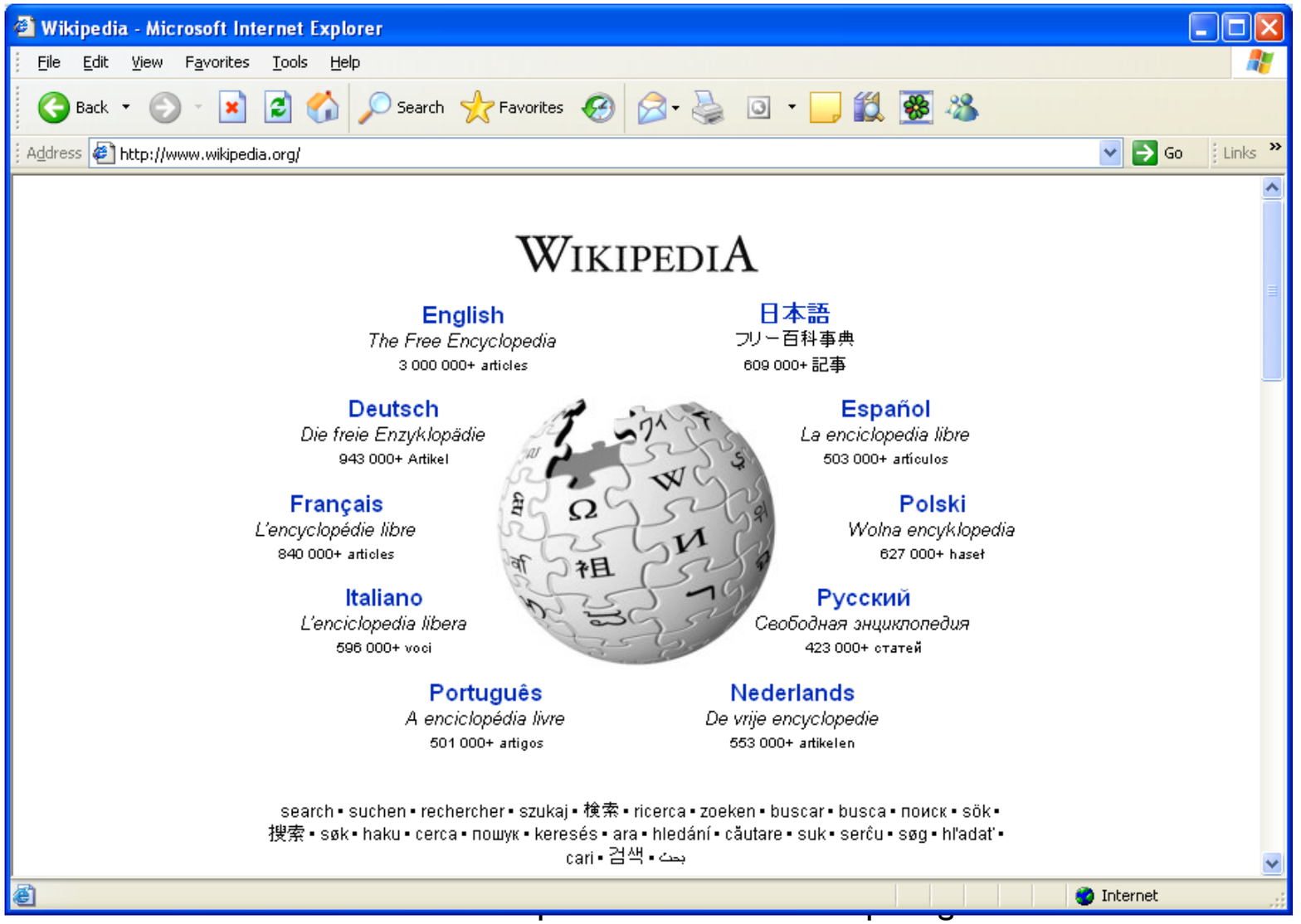


Distributed Human Computation (1)

- Objective: To encourage a huge population of Internet users to contribute to solve the difficult AI problems
- Example (1): Razor
  - To use human votes to determine if a given email is spam (anti-spam mechanism)
- Example (2): Proofreader
  - To give a (small) portion of the image file and corresponding text (generated by OCR) side-by-side to a human proofreader

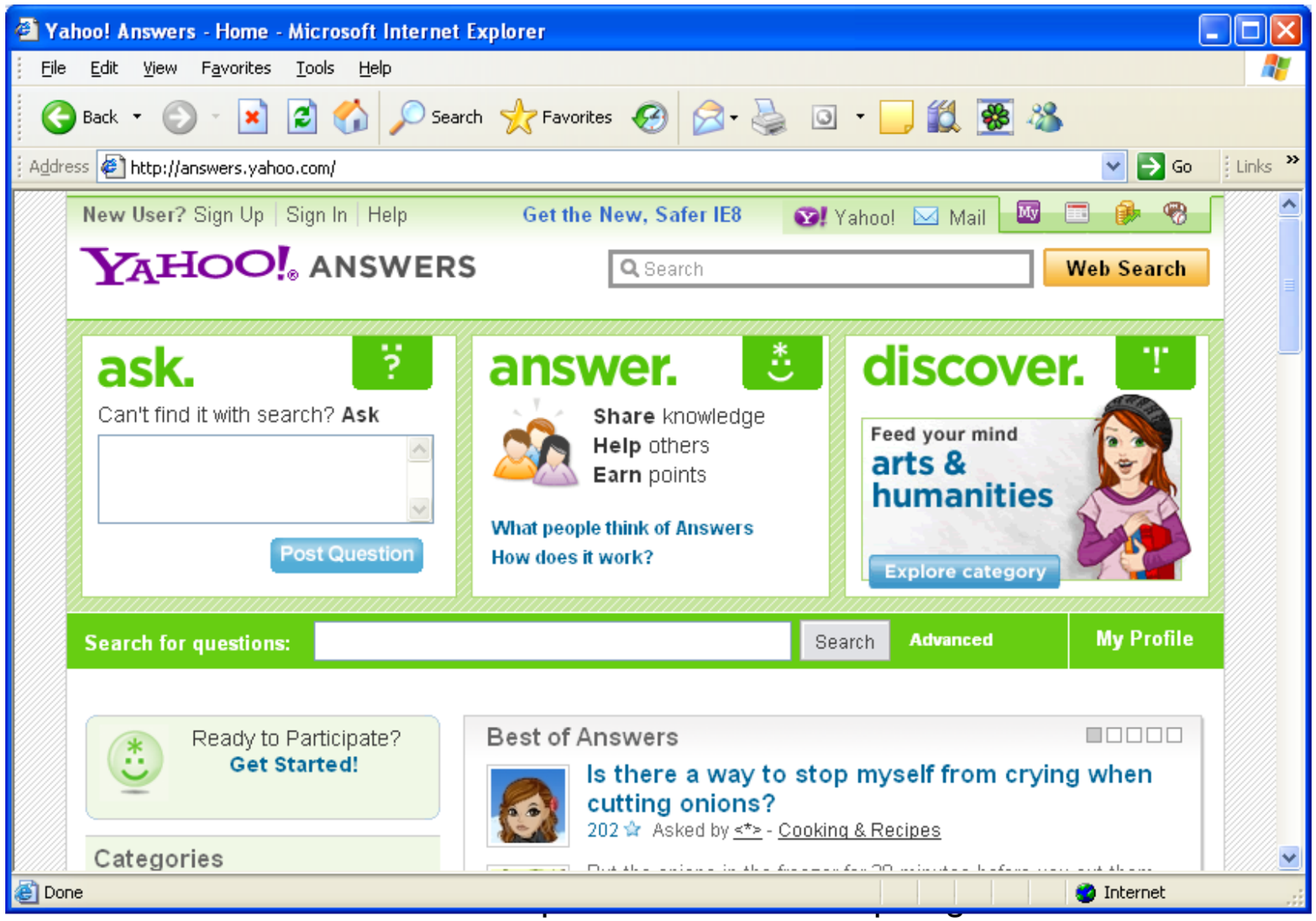
Distributed Human Computation (2)

- Example (3): Wikipedia
  - The collective knowledge is distributed in that essentially almost anyone can contribute to the Wiki



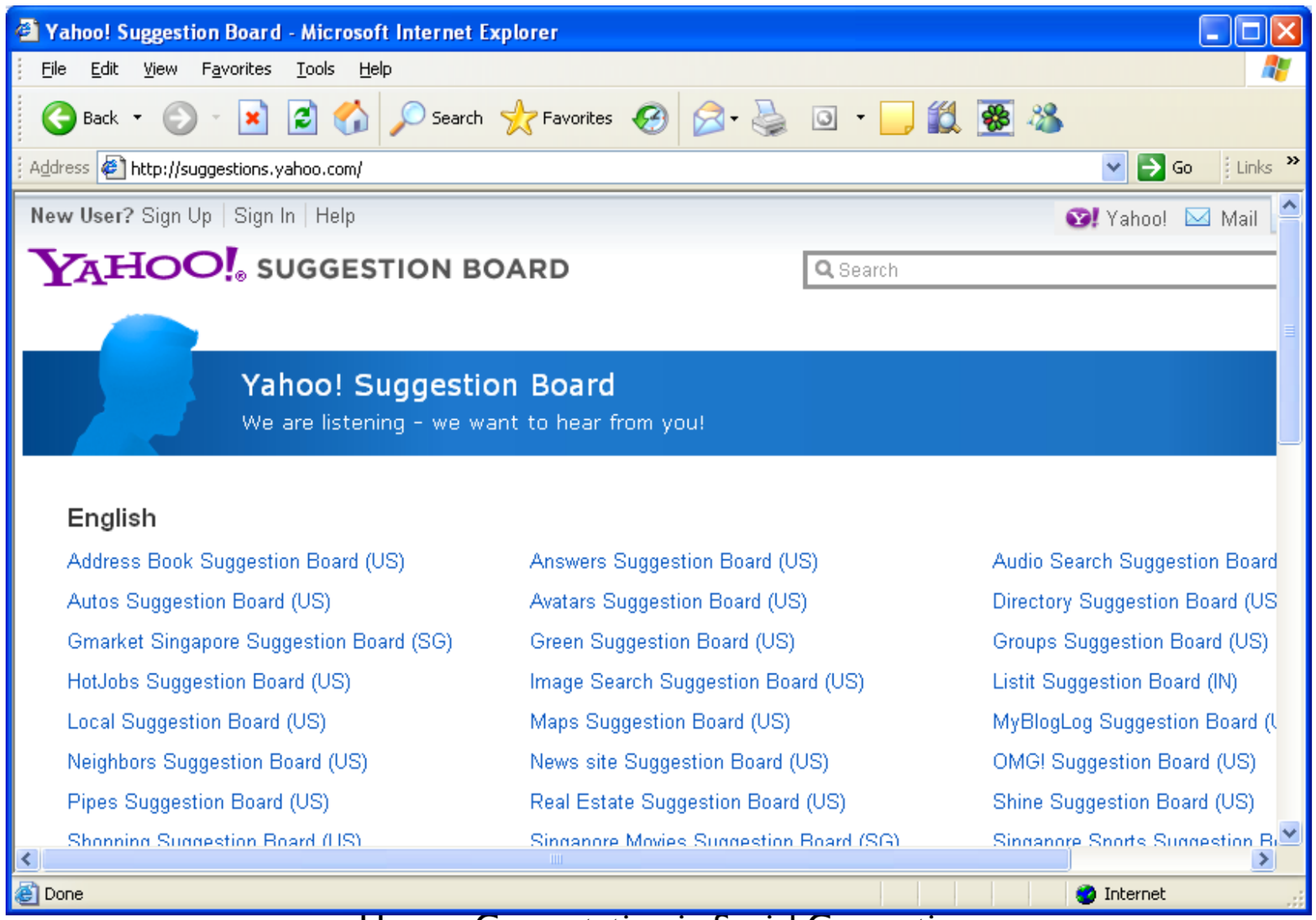
Distributed Human Computation (3)

- Example (4): Yahoo! Answers
  - To provide automated collection of human reviewed data at Internet-scale



Distributed Human Computation (4)

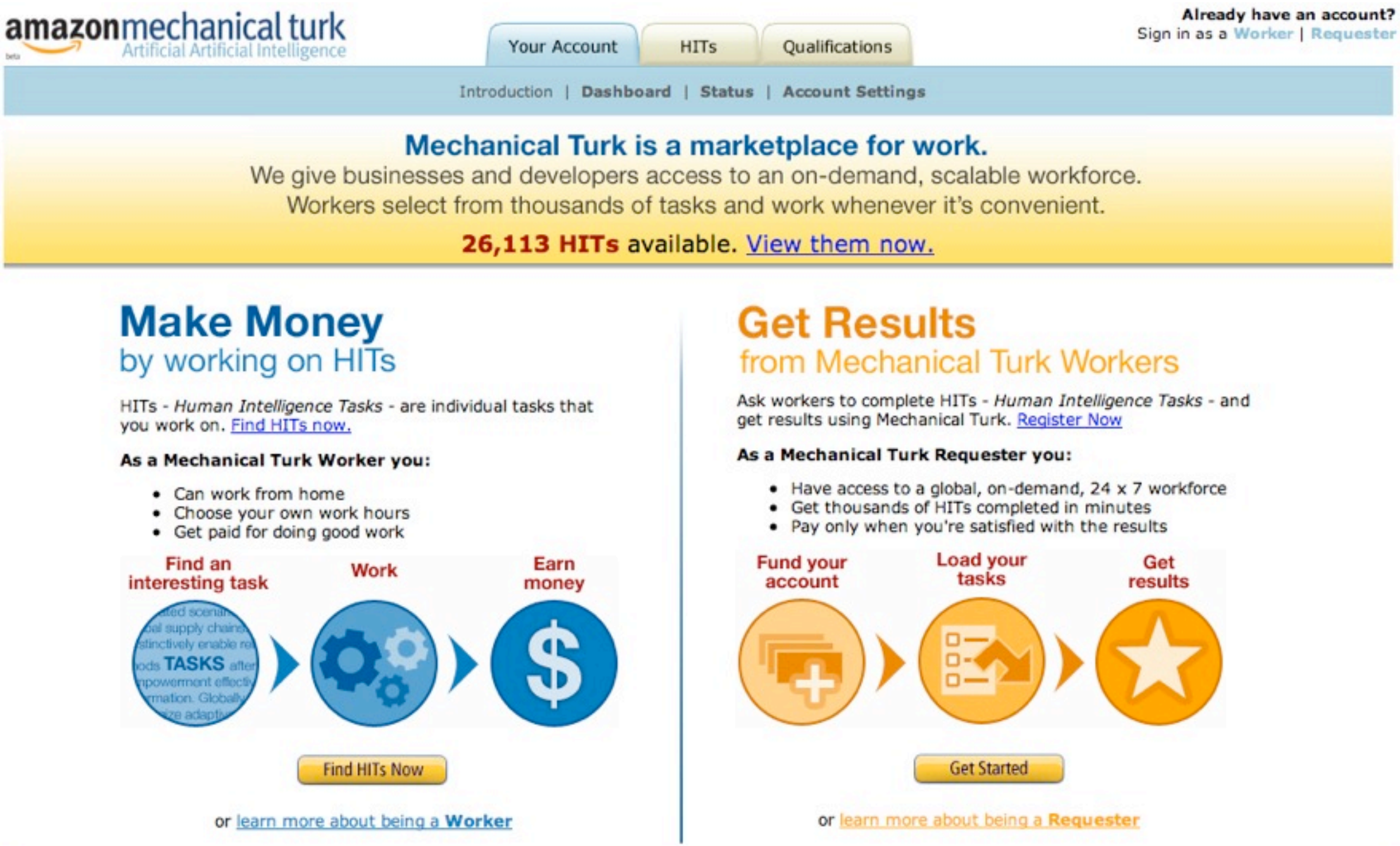
- Example (5): Yahoo! Suggestion Board
  - An Internet-scale feedback and suggestion system



Distributed Human Computation (5)

- Example (6): Amazon Mechanical Turk
  - It provides monetary rewards for tasks
- Example (7): LabelMe
  - A web-based tool for image annotation
  - Anybody can annotate image using it. You can only have access to the database once you have annotated a certain number of images.
- Example (8): 43Things
  - To collect goals from users and help them to find other users who have similar goals
- Example 9: MajorMiner
  - Music annotation game

Amazon Mechanical Turk



Example of Mechanical Turk

Answer a short survey

1. What is your gender?

- ○ Male
- ○ Female

2. What is your age?

3. Which of the following best describes your highest achieved education level?

Some High School

4. What is the total income of your household?

Less than $12,500
$12,500 - $24,999
$25,000 - $37,499
$37,500 - $49,999

5. What is your favorite type of TV Show? (select all that apply)

- ☐ Sports
- ☐ Situational Comedies
- ☐ Drama
- ☐ News
- ☐ Music Videos

Find the Website Address for this Restaurant

- For this restaurant below, enter the website address for the official website of the restaurant
- Include the full address, e.g. http://www.thecheesecakefactory.com
- Do not include URLs to city guides and listings like Citysearch.

Restaurant Name: **${name}**

Address: **${address}**

Phone Number: **${phone}**

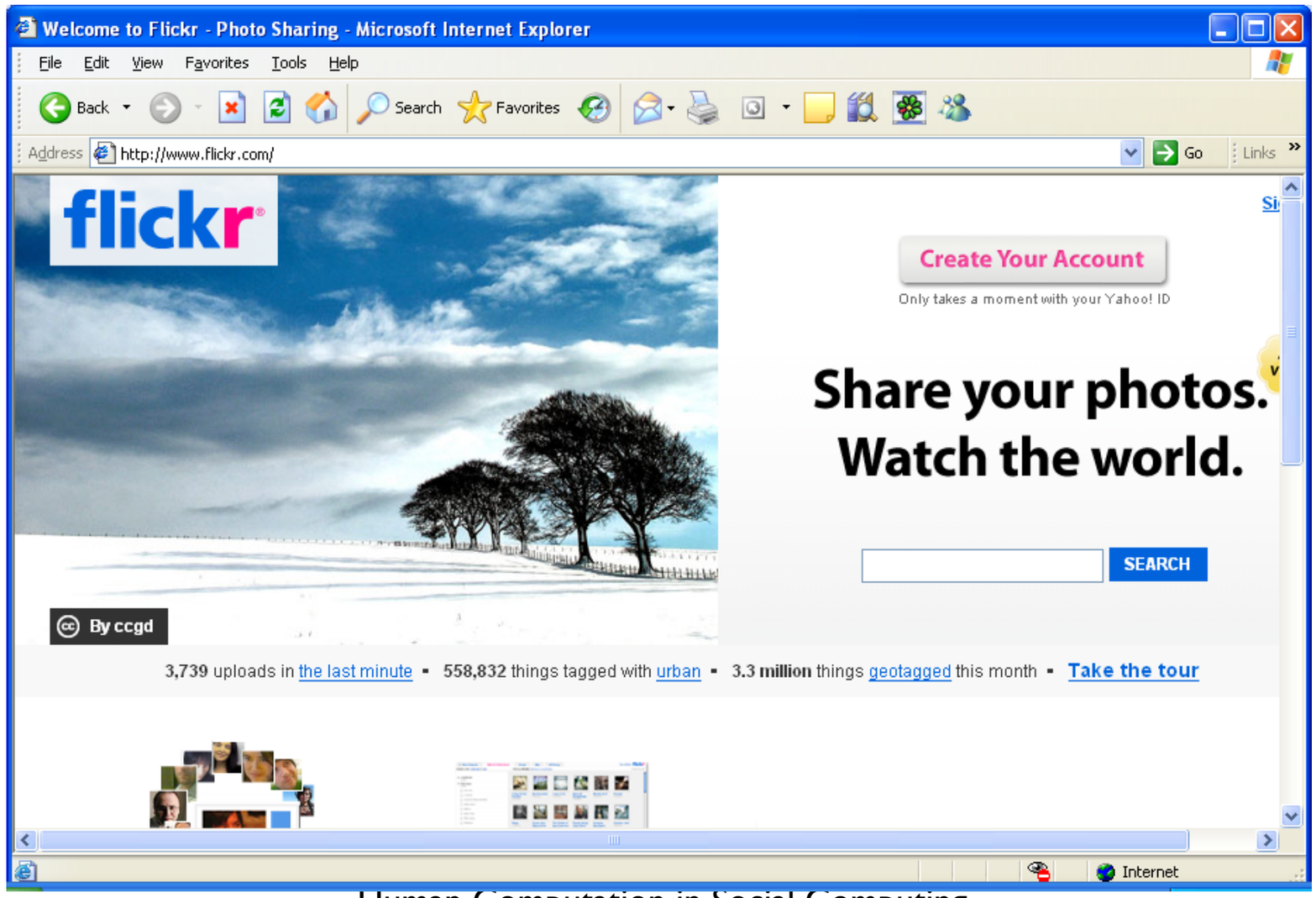
Website:

Please provide any comments you may have below, we appreciate your input!

Submit

Distributed Human Computation (6)

- Example (10): Yahoo's flickr
  - It is a photo-sharing site with captions being used as photo tags



Social Game-based Human Computation with Volunteers or Paid Engineers (1)

- Recently social games were proposed to collect accurate information from players as a side effect of their playing
- The players are volunteers or paid engineers
- Disadvantages:
  - Rely on online volunteers or paid engineers to enter information explicitly
  - Unable to scale up the system due to high cost
  - No validation mechanism to guarantee that the information collected is accurate

Social Game-based Human Computation with Volunteers or Paid Engineers (2)

- Most of the games at early stage aimed to collect commonsense knowledge.
- Example (1): Cyc
  - To collect information from the input by paid knowledge engineers
- Example (2): Open Mind
  - To collect common sense knowledge from people to develop intelligent software
  - Shortcoming: was too reliant on the unpaid volunteers to donate their time to contribute information

Social Game-based Human Computation with Volunteers or Paid Engineers (3)

- Example (2): Open Mind

Social Game-based Human Computation with Volunteers or Paid Engineers (4)

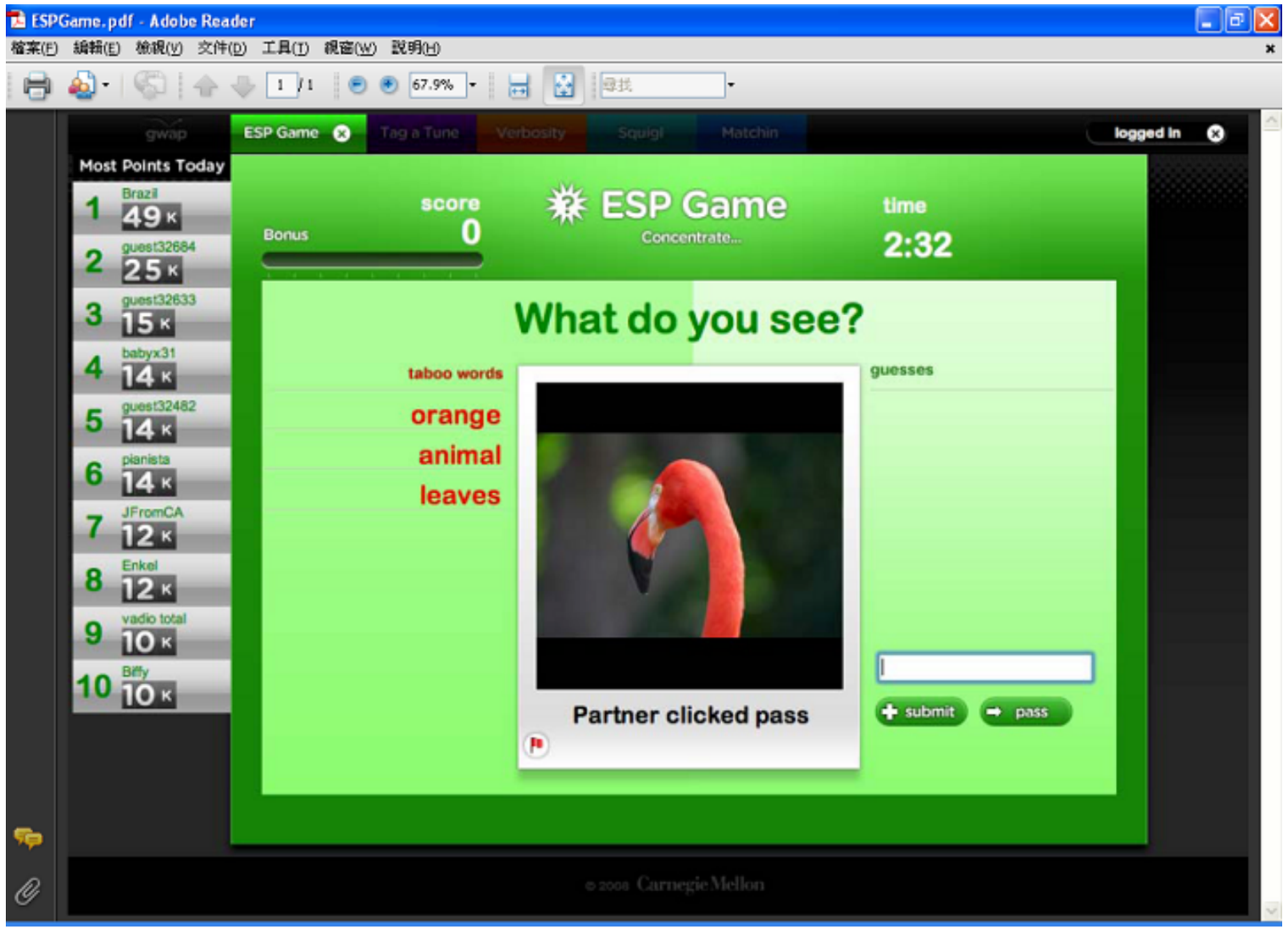
- Example (3): Mindpixel
  - Reward those Internet users who consistently validate a fact inline with the other users
  - Shortcoming: the cost is high!
- Example (4): Wildfire wally
  - To solve the maximum clique problem
  - Shortcoming: rely on unpaid volunteers to donate their time to contribute information

Social Game-based Human Computation with Online Players (1)

- Later, social games were proposed to collect information from the players as a side effect of their playing
- Advantage:
  - It encouraged more Internet users to contribute information to solve the AI problems because of the increasingly popularity of online game
- TWO important factors for collecting information effectively from players through a social game:
  - Guarantee the quality of collected information
  - Maintain the enjoyment of players in the game

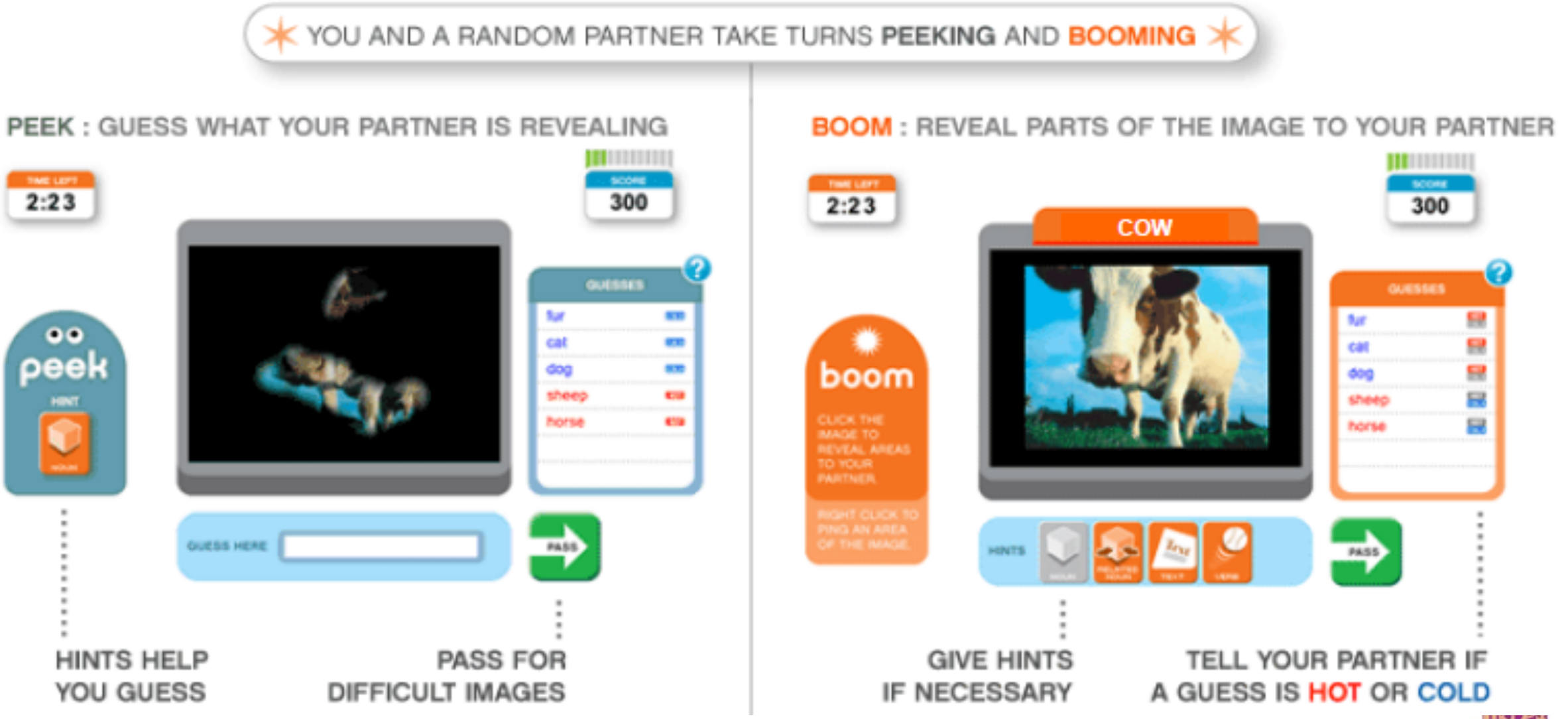
Social Game-based Human Computation with Online Players (2)

- To collect text information from images
  - Examples (1): ESP game



Social Game-based Human Computation with Online Players (3)

- To collect text information for images:
  - Examples (2): Peekaboom



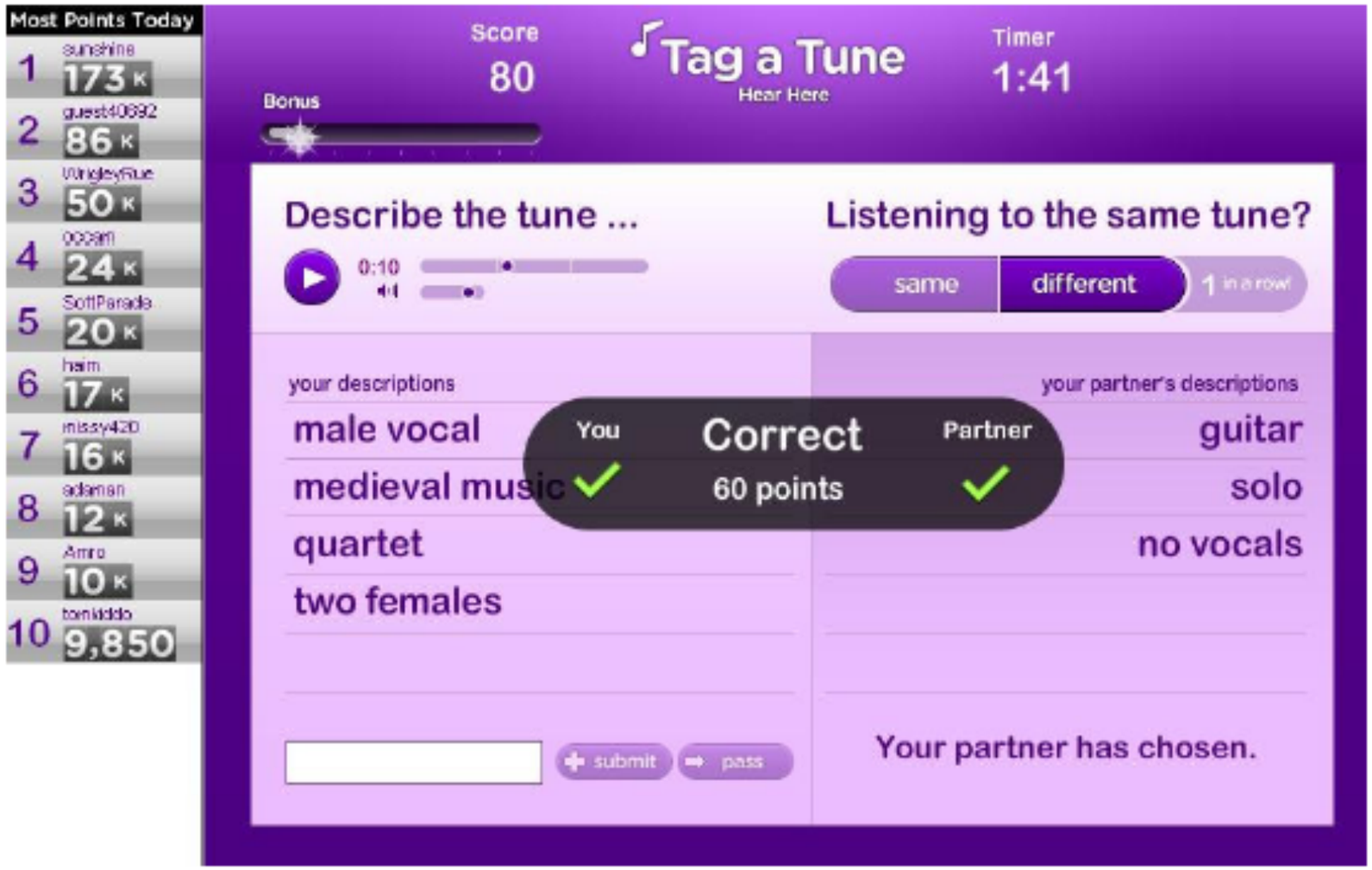
Social Game-based Human Computation with Online Players (4)

- To collect commonsense knowledge:
  - Examples (3): Verbosity

Figure 1. Part of the Narrator's screen.

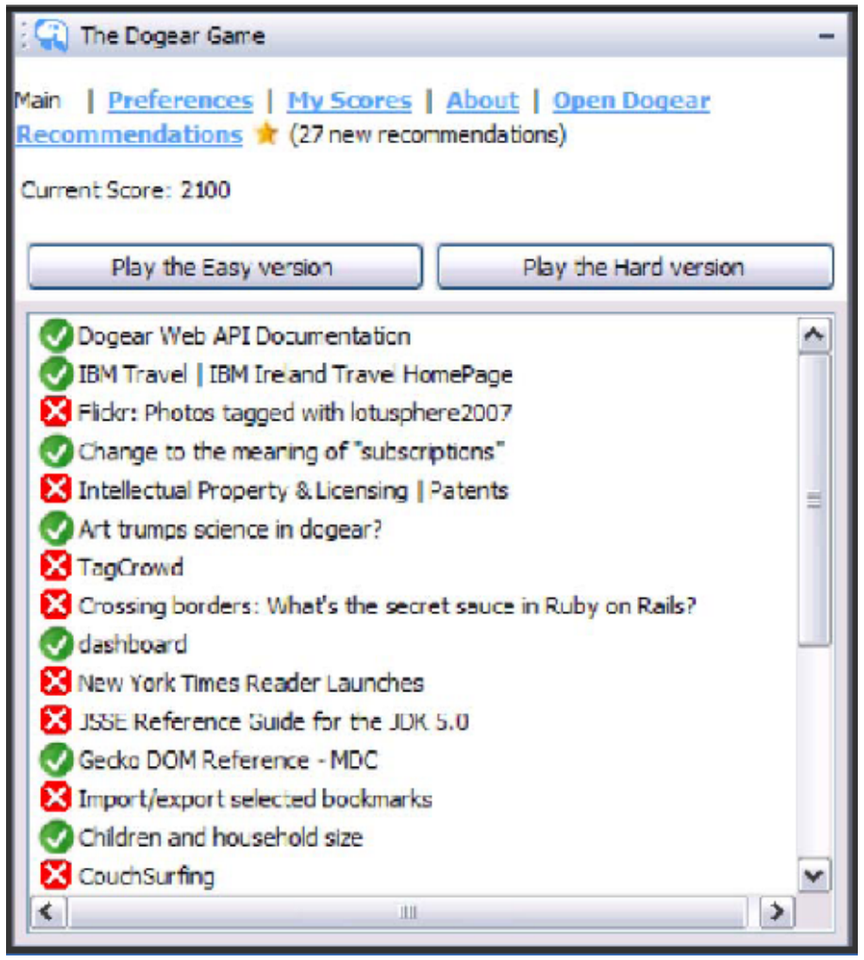
Social Game-based Human Computation with Online Players (5)

- To collect subjective descriptions of sounds and music:
  - Example (4): Tagatune



Social Game-based Human Computation with Online Players (6)

- To learn colleagues' bookmarks in an organizational goal:
  - Example (5): Dogear Game



Social Game-based Human Computation with Online Players (7)

- To tag locations in the real world through gameplay in mobile social games:
  - Example (6): Gopher guessing game

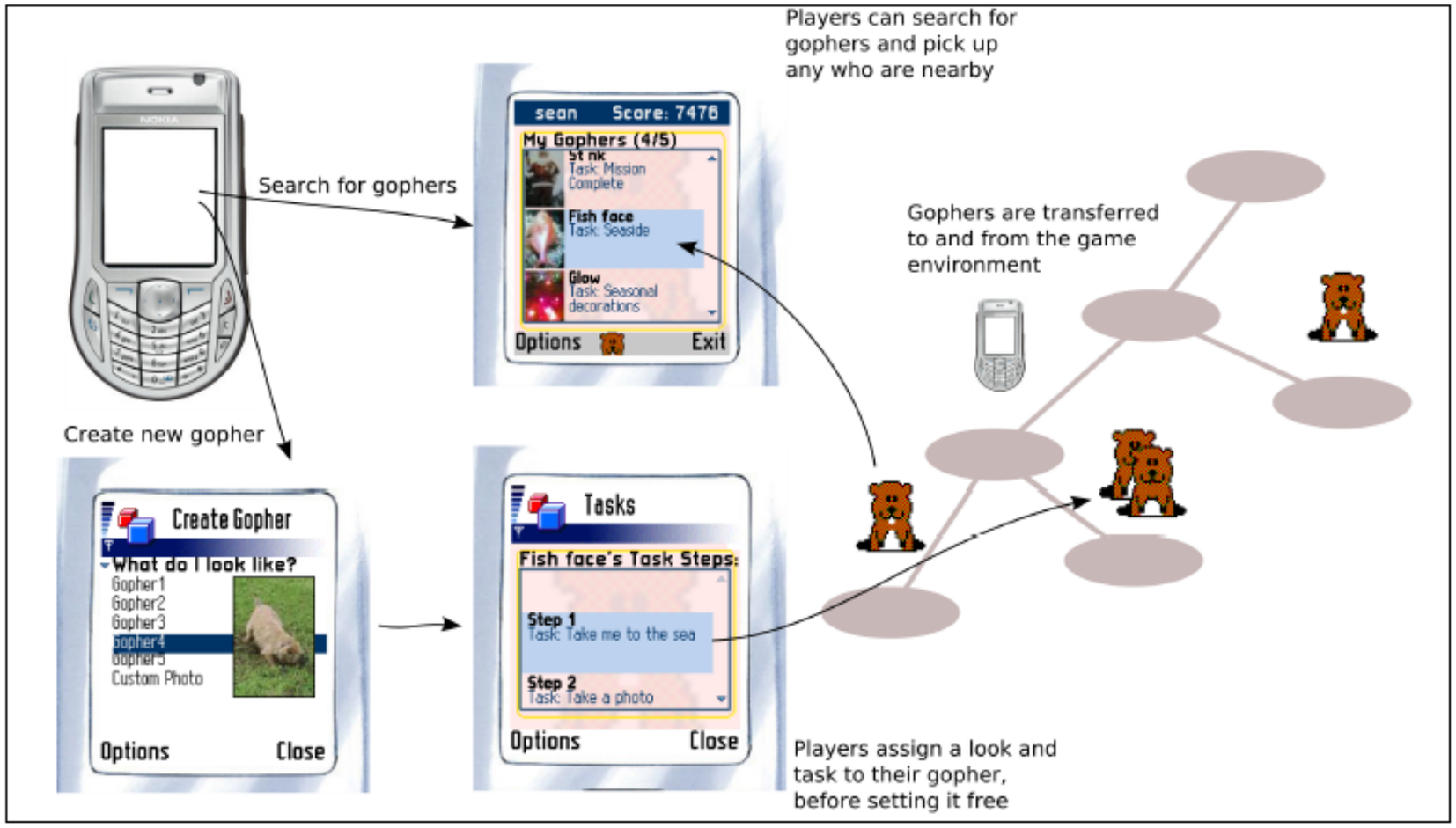


Figure 1. Real world experience, acquiring gophers

Social Game-based Human Computation with Online Players (8)

- To tag locations in the real world through gameplay in mobile social games:
  - Example (7): Gopher guessing game

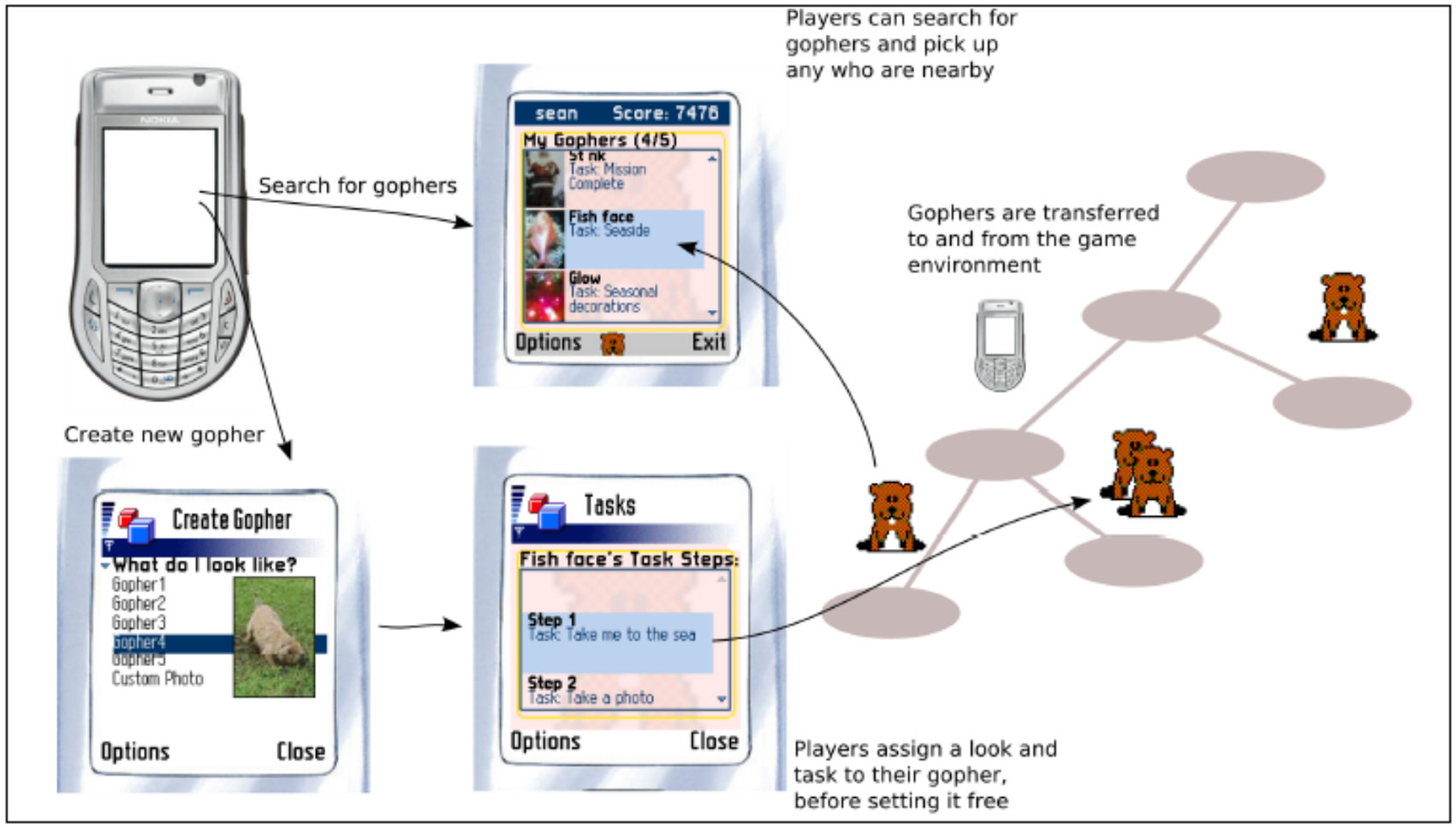
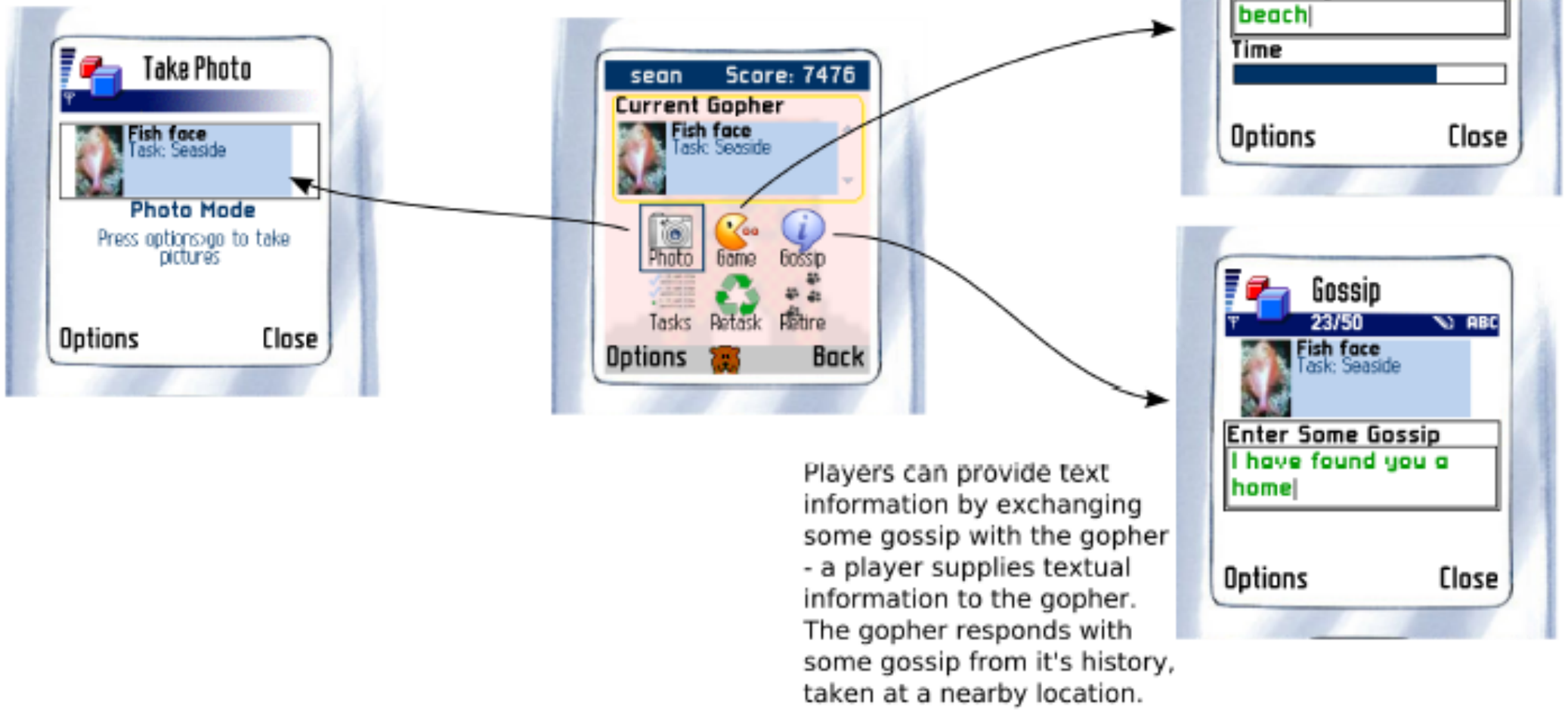


Figure 1. Real world experience, acquiring gophers

Visual feedback can be provided in the form of camera phone images - players photograph their current location and supply this to the gopher. The gopher responds with an image from its history, taken at a spatially nearby location.

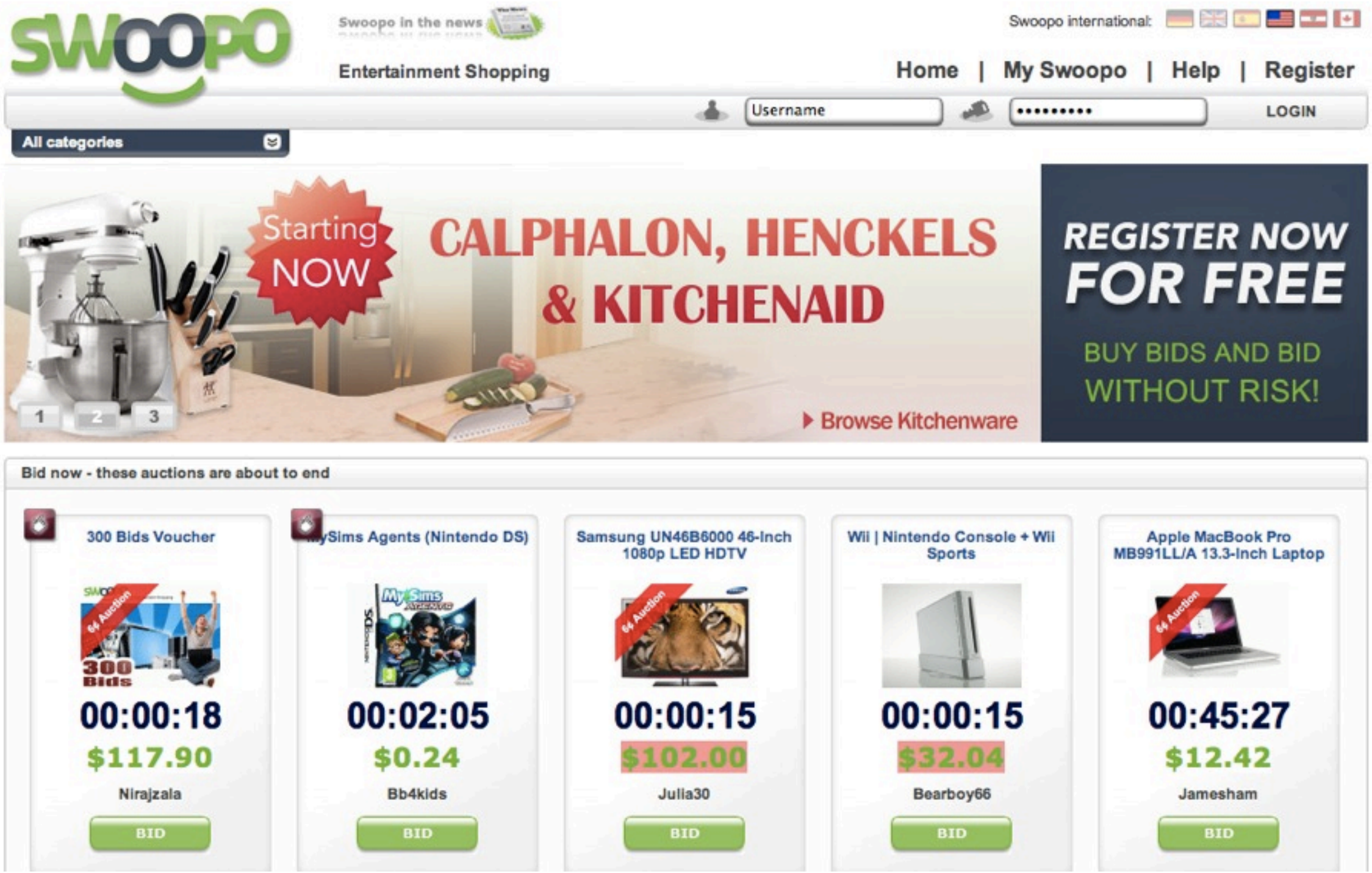
Gophers can participate in a word guessing game, based on their real-world location. Players supply semantic descriptions relative to their current whereabouts. They are awarded points depending on the accuracy of their guesses.



Players can provide text information by exchanging some gossip with the gopher - a player supplies textual information to the gopher. The gopher responds with some gossip from it's history, taken at a nearby location.

Figure 2. Real world experience, interacting with gophers

Entertainment Shopping



Categorization of Social Games

TABLE I
CATEGORIZATION OF SOCIAL GAMES

Game Structure	Verification Method	Game Mechanism
Output-agreement	Symmetric	Collaborative or Hybrid
Input-agreement	Symmetric	Collaborative or Hybrid
Inversion-problem	Asymmetric	Collaborative or Competitive or Hybrid
Output-optimization	Symmetric or Asymmetric	Collaborative or Competitive or Hybrid

Summary

TABLE II
CATEGORIZATION OF SOCIAL GAMES WITH EXAMPLES

Game Structure	Verification Method	Game Mechanism	Player Requirement		Examples
			Num of Player	Game Play	
Output-agreement	Symmetric	Collaborative	2	Synchronous	ESP, Matchi, Squigl, OntoGame
		Hybrid	Multi-players	Synchronous	Common Consensus, Social Heroes
		Hybrid	Multi-players	Asynchronous	Gopher Game
Input-agreement	Symmetric	Collaborative	2	Synchronous	TagATune
		Hybrid	N/A	N/A	N/A
Inversion-problem	Asymmetric	Collaborative	1 or 2	Synchronous	Peekaboom, Verbosity
		Competitive	2	Asynchronous	Dogear, CyPRESS, CARS
		Hybrid	1 or Multi-players	Synchronous	Phetch
Output-optimization	Symmetric	Collaborative	2	Synchronous	Restaurant Game
		Competitive	N/A	N/A	N/A
		Hybrid	Multi-players	Synchronous	Diplomacy

Crowsourcing

Sheng-Wei (Kuan-Ta) Chen, Institute of Information Science, Academia Sinica, Taipei, Taiwan

- Crowdsourcing = Crowd + Outsourcing
- Soliciting solutions via open calls to large-scale communities
  - INNOCENTIVE
  - oDesk
  - Amazon Mechanical Turk - Marketplace for work
  - Yahoo! Answers
  - Wikipedia

What Are Crowdsourceable?

- Software development - USD $25,000 per job
- Data entry - USD $4.4 per hour
- Image tagging - USD $0.04 per image
- General questions - points on Yahoo! Answers
- Image understanding - USD $0.01 to $0.02 per task
- Human action recognition - USD $0.01 per task
- Linguistic annotations (word similarity) - USD $0.2 per 30 word pairs

Multimedia QoE Assessment

- Quality of Experience (QoE) = User's subjective satisfaction about a service (multimedia content)
- To provide end-user experience, we measure the QoE of multimedia content, e.g, image, voice, video, etc.
  - Efficiency vs. Reliability
  - Objective evaluation approach
  - Subjection evaluation approach

Evaluation Approaches

- Objective Evaluation
  - Cannot capture all the QoE dimensions that may affect users' experiences
  - Cannot include external factors, e.g., quality of headsets, distance between the viewer and the display
- Subjective Evacuation
  - Opinions, e.g., 1=bad, 2=poor, 3=fair, 4=good, and 5=excellent
  - Difficult to define the ordinal scales concisely
  - Difficult to verify users' scoring results

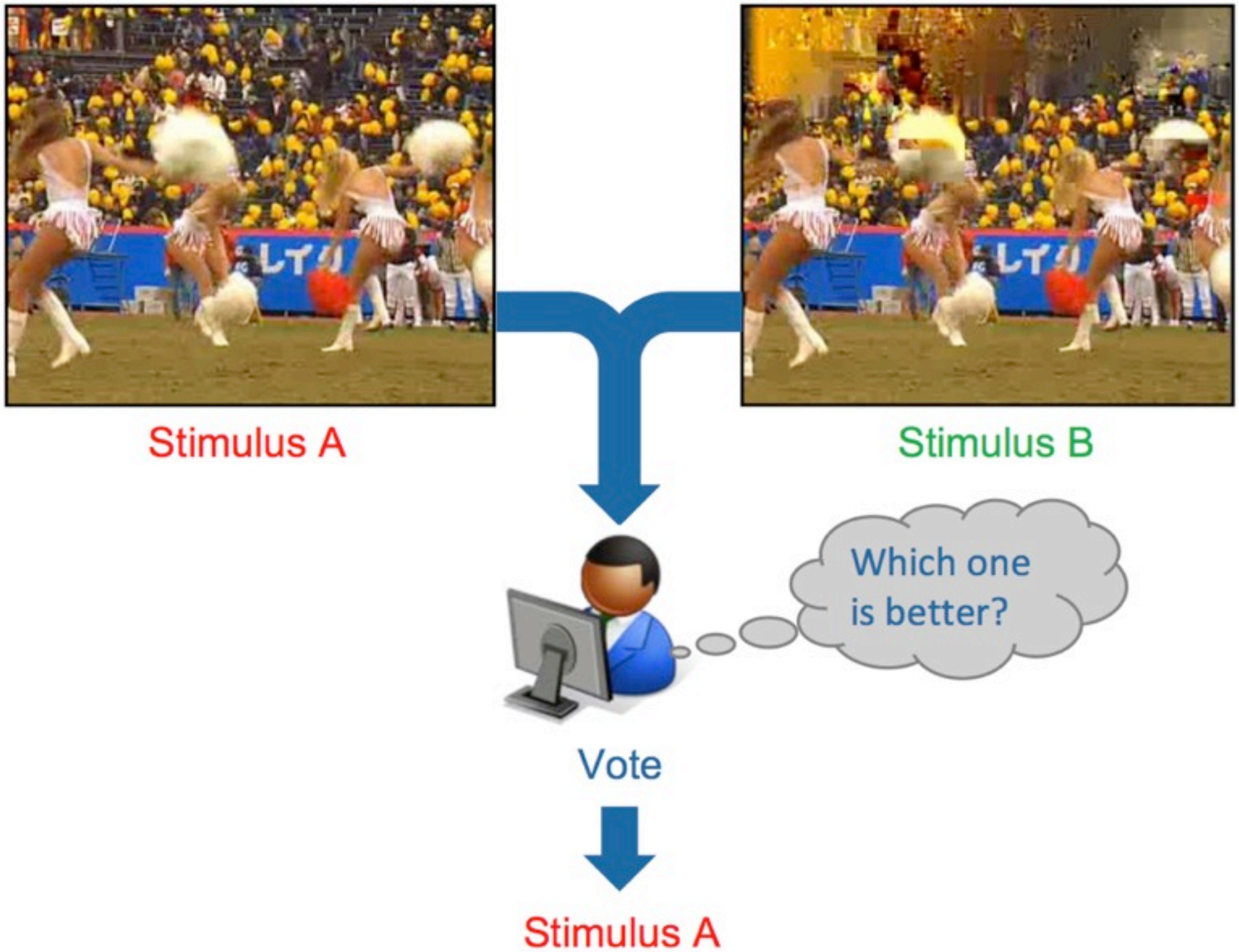
Drawbacks of Subjective Evaluation

- High economic cost
  - Participant payment
- High labor cost
  - Supervision labor
- Physical space/time requirements
  - Transportation cost
  - Laboratory space
  - Difficult to find motivated participants

Crowdsourcing Challenges

- Not every Internet user is trustworthy
  - Experiments without supervision so no quality assurance
  - Increased variance and bias
  - Need to find a way to detect problematic inputs!

Paired Comparison Test



Features of Paired Comparison

- Generalizable across a variety of multimedia applications
- Simple comparative judgement
- Interval scale QoE scores can be calculated
- Verifiable users' feedback

Verification of Users' Inputs

- Transitivity property
  - If A > B and B > C then A should be > C
- Transitivity Satisfaction Rate (TSR)

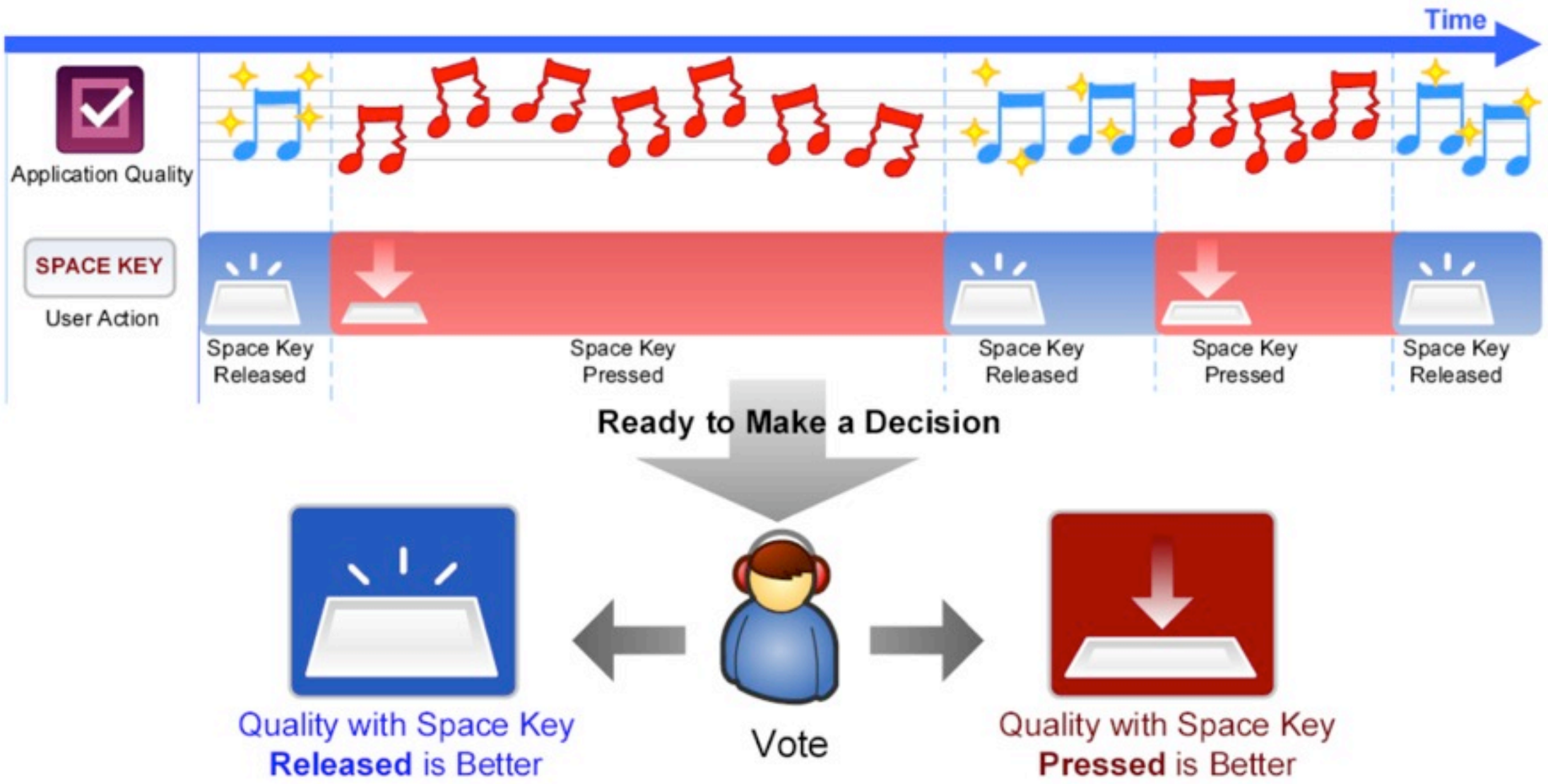
$$\frac{\#\text{ of triples satisfy the transitivity rule}}{\#\text{ of triples the transitivity rule may apply to}}$$

- Detect inconsistent judgements from problematic users
  - TSR = 1 => perfect consistency
  - TSR >= 0.8 => generally consistent
  - TSR < 0.8 => judgement are consistent

Experiment Design

- Suppose our task is to evaluate the effect of n audio processing algorithms, e.g., audio encoding
  - Select an audio clip (source clip) as the evaluation target
  - Apply the *n* algorithms to the source clip and generate *n* different versions of the clip (test clips)
  - Create an Adobe Flash-based system for users to evaluate the *n* test clips
  - A user need to perform 2 out of *n* paired comparison

Concept Flow of Acoustic QoE Evaluation



Which One is Better?

Participant Source

- Laboratory
  - Recruit part-time workers at an hourly rate of USD $8
- MTurk
  - Post experiments on the Mechanical Turk web site
    - Pay the participant USD $0.15 for each qualified experiment
- Community
  - Seek participants on the website of Internet community with 1.5 million members
  - Pay the participant an amount of virtual currency that was equivalent to USD $0.01 for each qualified experiment

Evaluation of the Framework

- Three participant sources
  - Laboratory
  - Amazon Mechanical Turk
  - Community
- Each with different cost structure
- Compare the cost required by each participant and the data quality produced

- The first **crowdsourcable** QoE evaluation framework
- Users' inputs can be **verified**
  - the transitivity property: A > B and B > C ➔ A > C
  - detect inconsistent judgements from problematic users
- Experiments can thus be outsourced to Internet crowd
  - **lower monetary cost**
  - **wider participant diversity**
  - **maintaining the evaluation results' quality**

Case Study	Experimenter Source	Total Cost (dollar)	# Rounds	# Person	Qualified Rate	Cost / Round (cent)	Time / Round (sec)	Avg. TSR
MP3 Bit Rate	Laboratory	50.97	1440	10	67%	3.54	16	0.96
	MTurk	7.50	750	24	47%	1.00	9	0.96
	Community	1.03	1,470	93	54%	0.07	25	0.96

Chen et al, "A Crowdsourceable QoE Evaluation Framework for Multimedia Content," *Proceedings of ACM Multimedia 2009*.

Summary

- Human computation is useful can be effective in performing intelligent tasks where computers cannot
- Crowdsourcing provides a new paradigm and a new platform for scientific research
- New applications, new methodologies, and new businesses are emerging with the aid of human computing/crowdsourcing

On-Going Research

Machine Learning

- Heavy-Tailed Symmetric Stochastic Neighbor Embedding (NIPS'09)
- Adaptive Regularization for Transductive Support Vector Machine (NIPS'09)
- Direct Zero-norm Optimization for Feature Selection (ICDM'08)
- Semi-supervised Learning from General Unlabeled Data (ICDM'08)
- Learning with Consistency between Inductive Functions and Kernels (NIPS'08)
- An Extended Level Method for Efficient Multiple Kernel Learning (NIPS'08)
- Semi-supervised Text Categorization by Active Search (CIKM'08)
- Transductive Support Vector Machine (NIPS'07)
- Global and local learning (ICML'04, JMLR'04)

On-Going Research

Web Intelligence/Information Retrieval

- A Generalized Co-HITS Algorithm and Its Application to Bipartite Graphs (KDD'09)
- Entropy-biased Models for Query Representation on the Click Graph (SIRIR'09)
- Effective Latent Space Graph-based Re-ranking Model with Global Consistency (WSDM'09)
- Formal Models for Expert Finding on DBLP Bibliography Data (ICDM'08)
- Learning Latent Semantic Relations from Query Logs for Query Suggestion (CIKM'08)
- RATE: a Review of Reviewers in a Manuscript Review Process (WI'08)
- MatchSim: link-based web page similarity measurements (WI'07)
- Diffusion rank: Ranking web pages based on heat diffusion equations (SIGIR'07)
- Web text classification (WWW'07)

On-Going Research

Recommender Systems/Collaborative Filtering

- Learning to Recommend with Social Trust Ensemble (SIRIR'09)
- Semi-Nonnegative Matrix Factorization with Global Statistical Consistency in Collaborative Filtering (CIKM'09)
- Recommender system: accurate recommendation based on sparse matrix (SIGIR'07)
- SoRec: Social Recommendation Using Probabilistic Matrix Factorization (CIKM'08)

Human Computation

- A Survey of Human Computation Systems (SCA2009)
- Mathematical Modeling of Social Games (SIAG2009)
- An Analytical Study of Puzzle Selection Strategies for the ESP Game (WI'08)
- An Analytical Approach to Optimizing The Utility of ESP Games (WI'08)

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King · Baeza-Yates (Eds.)

Weaving Services and People on the World Wide Web

Ever since its inception, the Web has changed the landscape of human experiences on how we interact with one another and data through service infrastructures via various computing devices. This interweaving environment is now becoming ever more embedded into devices and systems that integrate seamlessly on how we live, both in our working or leisure time.

For this volume, King and Baeza-Yates selected some pioneering and cutting-edge research work that is pointing to the future of the Web. Based on the Workshop Track of the 17th International World Wide Web Conference (WWW2008) in Beijing, they selected the top contributions and asked the authors to resubmit their work with a minimum of one third of additional material from their original workshop manuscripts to be considered for this volume. After a second-round of reviews and selection, 16 contributions were finally accepted.

The work within this volume represents the tip of an iceberg of the many exciting advancements on the WWW. It covers topics like semantic web services, location-based and mobile applications, personalized and context-dependent user interfaces, social networks, and folksonomies. The presentations aim at researchers in academia and industry by showcasing latest research findings. Overall they deliver an excellent picture of the current state-of-the-art, and will also serve as the basis for ongoing research discussions and point to new directions.

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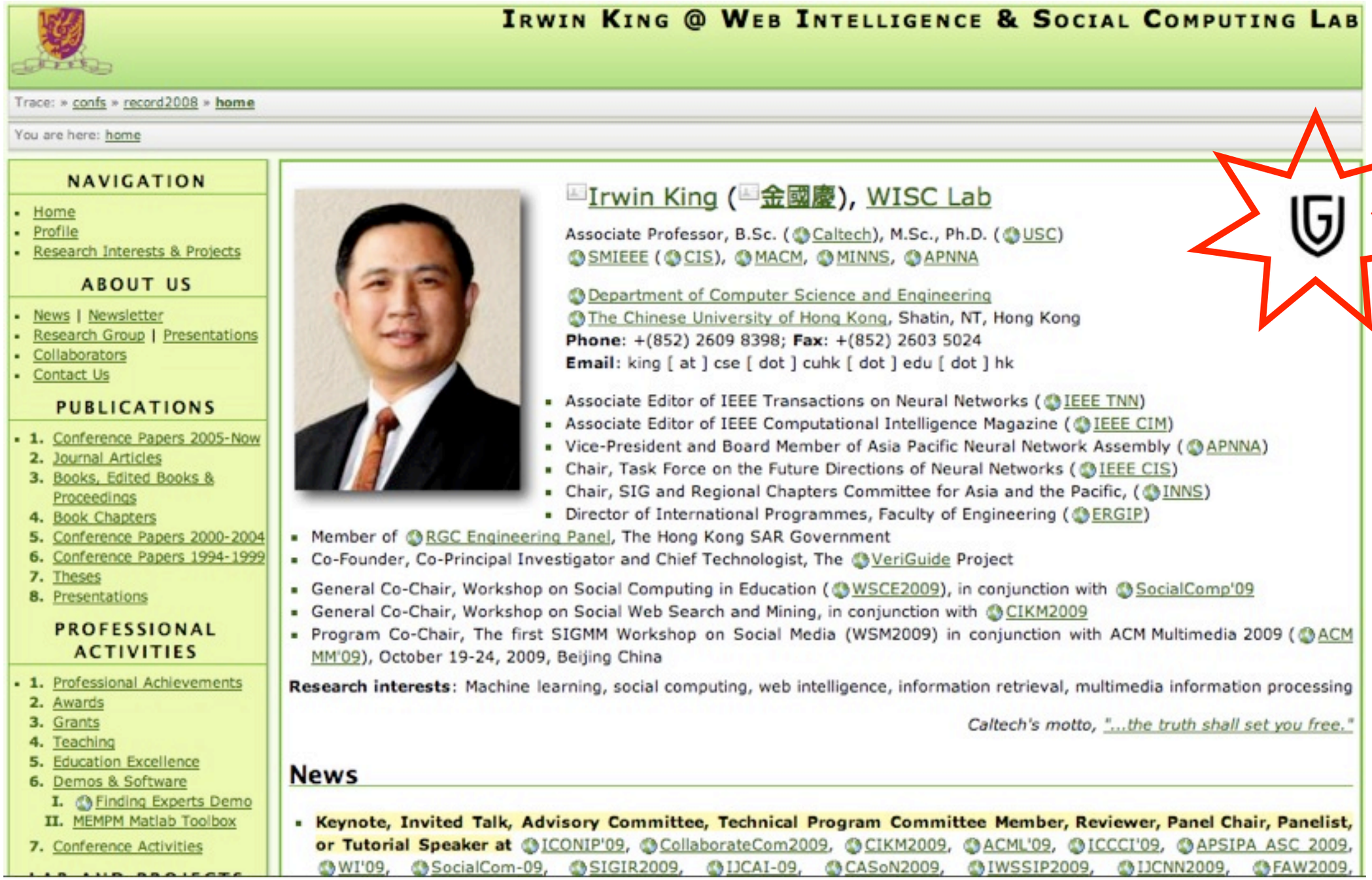

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