An Analytical Study of Puzzle Selection Strategies for the ESP Game

Ling-Jyh Chen, Bo-Chun Wang, Kuan-Ta Chen
Academia Sinica

Irwin King, and Jimmy Lee
The Chinese University of Hong Kong
How the ESP Game Works?

PLAYER 1

GUESSING: CAR

GUESSING: HAT

GUESSING: KID

SUCCESS!
YOU AGREE ON CAR

PLAYER 2

GUESSING: BOY

GUESSING: CAR

SUCCESS!
YOU AGREE ON CAR
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)
The Ideas behind the ESP Game

• “Human Computation” represents a new paradigm of applications.
  – solve some problems which are difficult to be solved by computers

• “Games With A Purpose” (GWAP) – by Dr. Luis von Ahn (CMU)
  – take advantage of people's desire to be entertained
  – produce useful metadata as a by-product
Our Contributions

• We propose an evaluation metric for human computation systems.

• We study the inner properties of the ESP game using analysis.

• We propose an “Optimal Puzzle Selection Algorithm” (OPSA).

• We present a comprehensive set of simulation results.

• Our model is easy and applicable to other ESP-like systems.
The Main Ideas

• There are two goals:
  – the system prefers to maximize the number of puzzles which have been played
  – the system prefers to take as many labels as possible for each puzzle

• Unfortunately, there is a trade-off between the two goals.
The Proposed Metric

$$\text{System Gain } (G) = \ln \left( \frac{N}{S} \right) \times \ln \left( \frac{S}{N} \right)$$

$\text{the number of the puzzles that have been played}$

$\text{the average score per puzzle}$

$r = \frac{T}{N} \Rightarrow N = \frac{T}{r}$

$T : \text{total played rounds}$

$r : \text{each puzzle should be played how many times in average}$

$$\frac{S}{N} = E[S] \times r$$

$r : \text{each puzzle should be played how many times in average}$

$E[S] : \text{the expected score value of each label}$
The Proposed Metric

System Gain \( (G) \)

\[ = \ln(N) \times \ln(S/N) \]

\[ = \ln(T/r) \times \ln(E[S] \times r) \]

\[ = -\left( \ln(r) - \frac{\ln(T) - \ln(E[S])}{2} \right)^2 + C \]

Maximum \( G = C \), when \( r = e^{\frac{\ln(T) - \ln(E[S])}{2}} \)
The Proposed Metric

Maximum \( G \)

\[
r = e^{\frac{\ln(T) - \ln(E[S])}{2}}
\]
Puzzle Selection Algorithms

• Optimal Puzzle Selection Algorithm (OPSA)
  – select a puzzle based on our analysis

• Random Puzzle Selection Algorithm (RPSA)
  – select a puzzle by random

• Fresh-first Puzzle Selection Algorithm (FPSA)
  – select a puzzle that has been played least frequently
Evaluation

- Using Monte Carlo Simulations
- # of rounds: $T = 10,000$
- # of puzzles: $100 \leq M \leq 5,000$
Conclusion

• We have proposed a metric to evaluate the performance of GWAP.

• We argue that GWAP needs to be “played with a strategy”.

• We propose the Optimal Puzzle Selection Algorithm (OPSA) for ESP-like games.
Thank You!

http://nrl.iis.sinica.edu.tw