ADAPTCHA: AN ADAPTIVE CAPTCHA FOR IMPROVED USER EXPERIENCE

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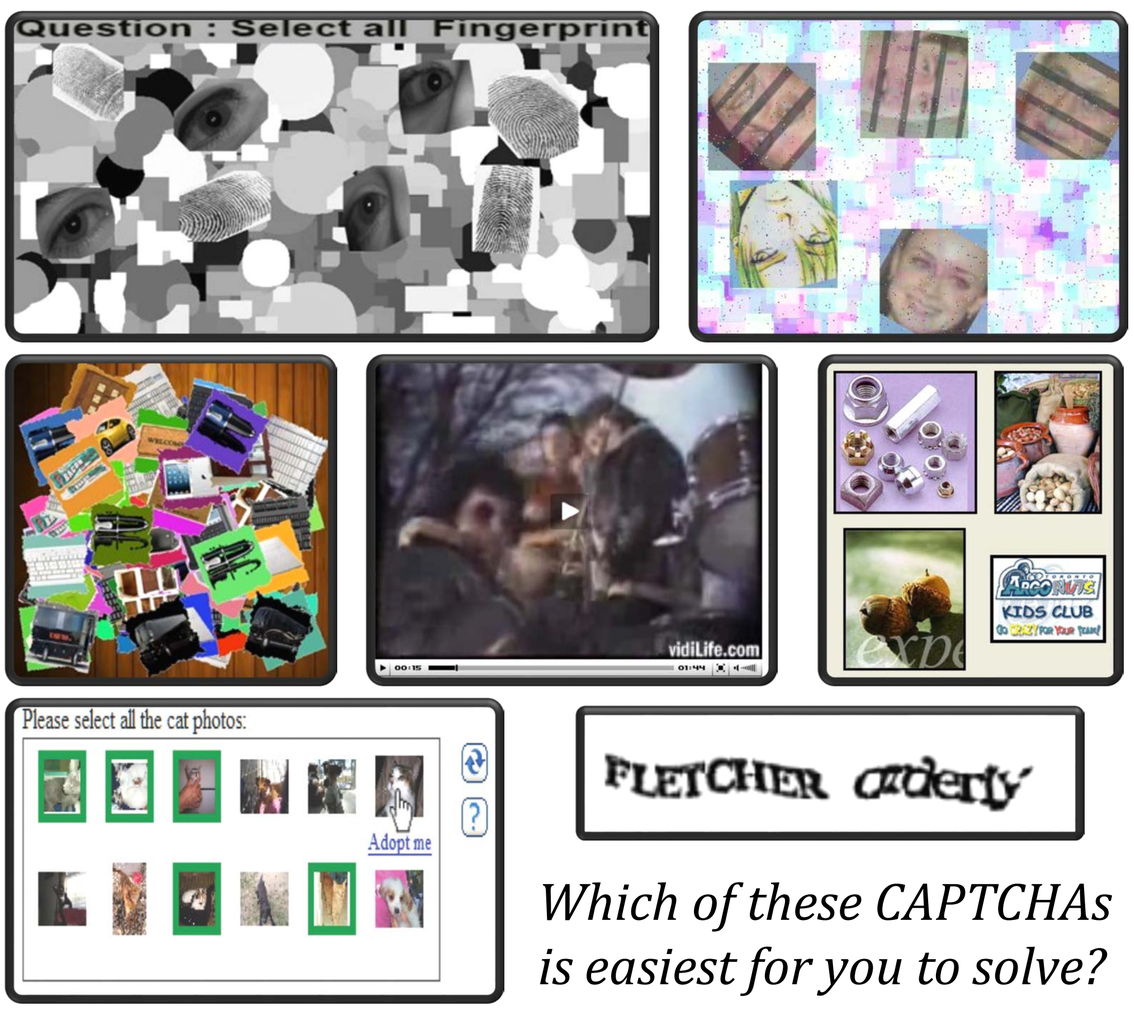
THE PROBLEM

CAPTCHAs are an important tool for **preventing automated attacks** against online systems but they can be a source of **friction** (undesirable delay and inconvenience) in the **user experience**. Good interface design strives to minimize potential sources of friction.



Which of these CAPTCHAs is easiest for you to solve?

PROPOSED SOLUTION

Adaptcha **reduces user experience friction** by presenting CAPTCHA tests which users are likely able to solve quickly and accurately.

Adaptcha **records metrics** of user performance including success rates and completion times. These values are compared against CAPTCHA metadata to adaptively select CAPTCHAs which experience suggests the user will find easiest to solve, providing a **low friction** user experience.

HOW ADAPTCHA WORKS

Adaptcha uses a **fitness proportionate selection** algorithm in its adaptive selection process. A **fitness value**, *f*, is calculated for each set of CAPTCHA characteristics (type, distortions, tagged keywords, etc.):

$$f = (0.8 s_{average}) + (0.2 t_{average})$$

where $s_{average}$ is the average success rate and $t_{average}$ is the average time to completion for CAPTCHAs already solved by the user sharing the same characteristics.

Initialization Stage → **Adaptive Stage (Phase-In)** → **Adaptive Stage (Fully Adaptive)**

STAGES OF OPERATION

Adaptcha's operation has two stages:

1. **Initialization Stage:** The first *3n* CAPTCHAs (*n*=number of CAPTCHA types) are selected to collect user performance metrics for each CAPTCHA type to support the adaptive selection process.
2. **Adaptive Stage:** Once initialization data has been collected, Adaptcha phases in adaptive selection of CAPTCHA tests:

$$Selection = \begin{cases} Adaptive, & \text{if } rand[0,1) \leq min(\frac{c}{50}, 0.95) \\ Random, & \text{otherwise} \end{cases}$$

where, *c* is the number of CAPTCHAs completed by the user. At least 5% of CAPTCHAs remain selected at random as a guard against automated attacks.

EXPERIMENTAL RESULTS

Adaptcha was tested using 4 image-based CAPTCHA types. **51 volunteers** made **3,319 attempts** at solving Adaptcha tests to access a protected website.

Adaptcha's adaptive selection process **improved success rates by 8 percentage points** and **reduced the time required to complete CAPTCHA tests by 35%**.

Phase (Number of Attempts Completed by User)	Success Rate	Average Time to Completion
Initialization Phase (12 attempts)	79.4%	14.5 seconds
Adaptive Phase (1-35 attempts)	86.7%	10.6 seconds
Adaptive Phase (beyond 35 attempts)	87.4%	9.5 seconds

See a live demo at http://adaptcha.captcharesearch.com