How Good are Humans at Solving CAPTCHAs? A Large Scale Evaluation

Elie Bursztein, Steven Bethard, Celine Fabry, John Mitchell, Dan Jurafsky,
How Good are Humans at Solving CAPTCHAs? A Large Scale Evaluation
CAPTCHA

Completely Automated Public Turing test to tell Computers and Humans Apart
In order to prove to us you are not a robot, select the three hot people:

meet me  meet me  meet me
meet me  meet me  meet me
meet me  meet me  meet me
meet me  meet me  meet me

No premium user. Please enter the one that can NOT be created from the unfolded pattern. 29 seconds remain.

A B C
D E F

Submit Proof I am Human

Download via Cogent #2
In order to prove to us you are not a robot, select the three hot people:

- meet me
- meet me
- meet me
- meet me
- meet me
- meet me
- meet me
- meet me

No premium user. Please enter the one that can NOT be created from the unfolded pattern. 29 seconds remain.

- Всем
- Только зарегистрированным пользователям
- Никому

\[ \lim_{x \to 0} \ln \left( 2 + \sqrt{\arctg x \cdot \sin \frac{1}{x}} \right) \]

Ведите ответ

Всё верно
No premium user. Please enter the one that can NOT be created from the unfolded pattern. 29 seconds remain.

Country code + mobile phone number:

Enter the characters for the symbols shown in the box below:

= d  = x  = e  = m  = j

= y  = h  + 4  = p  > = w
http://www.youtube.com/watch?v=xIxDJof7xxQ video that demonstrate HTML5 upcoming features
about 23 hours ago via yoono

OAuth 2.0 Draft is out. OAuth is the protocol used by Twitter to authenticate app. Get ready to update your code :)
10:10 AM Apr 22nd via yoono

A great visualization of HTML5 and CSS3 features readiness
10:03 AM Apr 22nd via yoono

RSnake Gotta love Chrome: http://ha.ckers.org/blog/20100414/chrome-phishing/
7:03 AM Apr 14th via web
Retweeted by you and 16 others
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Get 100 Twitter Followers Free!
We find high quality, real people, active followers for you, they all willing to follow you, and listen to you.
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How Good are Humans at Solving CAPTCHAs? A Large Scale Evaluation

93%
How Good are Humans at Solving CAPTCHAs? A Large Scale Evaluation

<table>
<thead>
<tr>
<th>Company</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baidu</td>
<td>93%</td>
</tr>
<tr>
<td>Google</td>
<td>86%</td>
</tr>
<tr>
<td>Mail.ru</td>
<td>70%</td>
</tr>
</tbody>
</table>
How Good are Humans at Solving CAPTCHAs? A Large Scale Evaluation
How Good are Humans at Solving CAPTCHAs? A Large Scale Evaluation

- Yahoo!
- Digg
- eBay
- Blizzard

Time taken:
- 8.2 sec
- 7.3 sec
How Good are Humans at Solving CAPTCHAs? A Large Scale Evaluation

8.2 sec

7.3 sec

9.3 sec
How Good are Humans at Solving CAPTCHAs? A Large Scale Evaluation

- **Yahoo!**: 10.6 sec
- **Digg**: 8.2 sec
- **eBay**: 7.3 sec
- **Blizzard**: 9.3 sec
Outline

- Study methodology
- Population demography
- Captcha measures
Accuracy
Accuracy

Solving time
The supply chain

Websites

Scraping

Paper
The supply chain

Websites

Scraping

Solving

Paper
The supply chain

Websites → Scaping → Solving → Data Mining → Paper
Scraping

- Alexa top 50
- 23 scheme
- 10 000 captcha samples
- Custom scraper
  - Cookies
  - Javascript events
  - Ip rate limiting
  - User agent
Scraping

- Alexa top 50
- 23 scheme
- 10,000 captcha samples
- Custom scraper
  - Cookies
  - Javascript events
  - Ip rate limiting
  - User agent
Authorize
Authorize

Baidu

captcha.net
Authorize

Baidu

captcha.net

eBay
Authorize
Baidu
captcha.net
eBay
Digg
Authorize

Baidu

captcha.net

eBay

Digg

Google
Authorize
Baidu
captcha.net
eBay
Digg
Google
Blizzard
Authorize
Baidu
captcha.net
eBay
Digg
Google
Blizzard
Yahoo
Microsoft
recaptcha
Authorize
Baidu
captcha.net
eBay
Digg
Google
Blizzard
Yahoo
Microsoft
recaptcha
Skyrock
Slashdot
mail.ru
Authorize
Authorize

Digg
Authorize

Digg

eBay
Authorize

Microsoft

Digg

recaptcha

eBay

leathers

Slashdot

Google
Precision is costly
Precision is costly

0.1% Precision accuracy
Precision is costly

\[ 1000 \times 3 \]

0.1% Precision accuracy

Knowing the probable answer
Precision is costly

1000 × 3

0.1% Precision accuracy

Knowing the probable answer

3000 by scheme
Precision is costly
Precision is costly

63000
captcha
Captcha-Bypass. CAPTCHA ends here.

Get tired of CAPTCHAs or cannot enter them? We have a ready solution for you.

Captcha-Bypass benefits

Here are our key features. You can find full feature list here.

- We offer the **least price** comparing to our competitors: **from $0.005 per CAPTCHA**
- **iMacros** support
- **Success rate** is about 95-100%

- **We solve** all **CAPTCHA**s. From any site. Yes, 24/7.
- Integration with many programming languages: **.NET, PHP, C++, Java**
- Great response time: about 5-15 seconds

Order now **Order CAPTCHAs Now**
MTurk by Amazon

Worker(s)

Requester (us)
# Requester interface

<table>
<thead>
<tr>
<th>Requester:</th>
<th>Elie Bursztein</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIT Expiration Date:</td>
<td>Apr 24 2010, 07:52 PM PDT</td>
</tr>
<tr>
<td>Reward:</td>
<td>$0.10</td>
</tr>
<tr>
<td>Assignments Requested:</td>
<td>1214</td>
</tr>
<tr>
<td>Description:</td>
<td>Do 20 image captchas for us and answer few questions about yourself. Should take you between 1 and 3 mn. You might get a bonus of a 5$ if you do the task well.</td>
</tr>
<tr>
<td>Keywords:</td>
<td>captcha, image, annotation, extraction, img, text, input, images, easy</td>
</tr>
</tbody>
</table>

This CAPTCHA study is part of a Stanford project designed to measure how fast and efficiently you are at solving CAPTCHAs.

Please before starting to solve captcha fill out the following questions:

- **Gender**
  - Male
  - Female

- **Age**
  - [ ]

- **Education Level**
  - Select One

- **What is your native language?**
  - Select One

- **If English is not your native language, how well do you speak English?**
  - [ ]

- **What industry do you work in?**
  - Select One

- **I was born in**
  - United States

- **I am living in**
  - United States

- **Roughly how many years have you been a computer user?**
### Worker interface

![Worker interface](image)

**Dashboard - Elie Bursztein** (If you're not Elie Bursztein, click here.)

#### Total Earnings

<table>
<thead>
<tr>
<th>Rewards You Have Earned</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approved HITs</td>
<td>$0.00</td>
</tr>
<tr>
<td>Bonuses</td>
<td>$0.00</td>
</tr>
<tr>
<td>Total Earnings</td>
<td>$0.00</td>
</tr>
</tbody>
</table>

#### HIT Totals

<table>
<thead>
<tr>
<th>HITs You HaveAccepted</th>
<th>Value</th>
<th>Rate</th>
<th>HITs You Have Submitted</th>
<th>Value</th>
<th>Rate</th>
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</thead>
<tbody>
<tr>
<td>HITs Accepted</td>
<td>0</td>
<td>--</td>
<td>HITs Submitted</td>
<td>0</td>
<td>--</td>
</tr>
<tr>
<td>... Submitted</td>
<td>0</td>
<td>--</td>
<td>... Approved</td>
<td>0</td>
<td>--</td>
</tr>
<tr>
<td>... Returned</td>
<td>0</td>
<td>--</td>
<td>... Rejected</td>
<td>0</td>
<td>--</td>
</tr>
<tr>
<td>... Abandoned</td>
<td>0</td>
<td>--</td>
<td>... Pending</td>
<td>0</td>
<td>--</td>
</tr>
</tbody>
</table>

#### HITs Available to You

<table>
<thead>
<tr>
<th>Title</th>
<th>Requester</th>
<th>Reward</th>
<th># of HITs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Find 5 Number's Link &amp; Get Money - 2</td>
<td>Kaan SAKA</td>
<td>$3.50</td>
<td>1</td>
</tr>
<tr>
<td>Find Broken Links or repeated photos !!!</td>
<td>Kaan SAKA</td>
<td>$3.50</td>
<td>1</td>
</tr>
<tr>
<td>Find Broken Links or repeated photos !!!</td>
<td>Kaan SAKA</td>
<td>$3.50</td>
<td>1</td>
</tr>
<tr>
<td>Find Broken Links or repeated photos !!!</td>
<td>Kaan SAKA</td>
<td>$3.50</td>
<td>1</td>
</tr>
<tr>
<td>Find Broken Links or repeated photos !!!</td>
<td>Kaan SAKA</td>
<td>$3.50</td>
<td>1</td>
</tr>
<tr>
<td>Test our website's functionality!</td>
<td>Viky Shamwow</td>
<td>$2.00</td>
<td>3</td>
</tr>
<tr>
<td>Check the Functionality of Our Site!</td>
<td>John Finskiy</td>
<td>$2.00</td>
<td>2</td>
</tr>
</tbody>
</table>
Largest captcha experiment ever

- 8 audio schemes
Largest captcha experiment ever

- 8 audio schemes
- 13 images schemes
Largest captcha experiment ever

- 8 audio schemes
- 13 images schemes
- 1000 x 3 image captchas / scheme (bypass-captcha)
Largest captcha experiment ever

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- 13 images schemes
- 1000 x 3 image captchas / scheme (bypass-captcha)
- 3500 x 3 audio captchas / scheme (MTurk)
Largest captcha experiment ever

- 8 audio schemes
- 13 images schemes
- $1000 \times 3$ image captchas / scheme (bypass-captcha)
- $3500 \times 3$ audio captchas / scheme (MTurk)
- $5000 \times 3$ image captchas / scheme (MTurk)
Largest captcha experiment ever

- 8 audio schemes
- 13 images schemes
- 1000 × 3 image captchas / scheme (bypass-captcha)
- 3500 × 3 audio captchas / scheme (MTurk)
- 5000 × 3 image captchas / scheme (MTurk)
- 318 000 captchas annotated overall
Language repartition

- Tamil: 3502
- English: 2791
- Malayalam: 625
- Hindi/Urdu: 578
- Telugu: 331
- Punjabi: 15
- Gujarati: 149
- Other: 12
- Balochi: 13
- Portuguese: 15
- Hebrew: 15
- Russian: 12
- Arabic: 19
- Macedonian: 21
- Dutch: 21
- Cebuano: 17
- Slovene: 33
- Marathi: 39
- Mandarin: 51
- Bengali: 52
- Kannada: 64
- Spanish: 71
- Romanian: 95
- Telugu: 331
- Hindi/Urdu: 578
- Malayalam: 625
- English: 2791
- Tamil: 3502
Repartition by education

- 55% Bachelors
- 27% High School
- 16% Master
- 1% No formal education
- 1% Ph.D

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Age repartition

Number of users

Age range

18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72

205 239 686 658 429 647 230 361 351 318 364 388 388 364 351 318 268 182 177 133 137 91 76 104 103 106 103 113 137 132 91 76 37 38 70 46 56 42 26 58 35 26 18 11 21 12 16 2 6 1 2 16 15 2 2 1
How Good are Humans at Solving CAPTCHAs? A Large Scale Evaluation

Nb of user distinct answer for image scheme (bp)

- Yahoo: 70.492
- Blizzard: 71.635
- Slashdot: 46.855
- Skyrock: 79.557
- Recapcha: 40.576
- Microsoft: 68.49
- Mail.ru: 42.512
- Google: 70.667
- eBay: 80.672
- Digg: 64.253
- Captchas.net: 43.852
- Baidu: 73.793
- Authorize: 85.484

<table>
<thead>
<tr>
<th>Platform</th>
<th>1 answer</th>
<th>2 answer</th>
<th>3 answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yahoo</td>
<td>25.615</td>
<td>3.8934</td>
<td>70.492</td>
</tr>
<tr>
<td>Blizzard</td>
<td>24.519</td>
<td>3.8462</td>
<td>71.635</td>
</tr>
<tr>
<td>Slashdot</td>
<td>19.306</td>
<td>19.306</td>
<td>46.855</td>
</tr>
<tr>
<td>Skyrock</td>
<td>18.966</td>
<td>1.4778</td>
<td>79.557</td>
</tr>
<tr>
<td>Recapcha</td>
<td>21.729</td>
<td>21.729</td>
<td>40.576</td>
</tr>
<tr>
<td>Microsoft</td>
<td>25.821</td>
<td>5.6893</td>
<td>68.49</td>
</tr>
<tr>
<td>Mail.ru</td>
<td>20.048</td>
<td>20.048</td>
<td>42.512</td>
</tr>
<tr>
<td>Google</td>
<td>24</td>
<td>5.3333</td>
<td>70.667</td>
</tr>
<tr>
<td>eBay</td>
<td>16.597</td>
<td>2.7311</td>
<td>80.672</td>
</tr>
<tr>
<td>Digg</td>
<td>30.543</td>
<td>5.2036</td>
<td>64.253</td>
</tr>
<tr>
<td>Captchas.net</td>
<td>42.008</td>
<td>14.139</td>
<td>43.852</td>
</tr>
<tr>
<td>Baidu</td>
<td>21.839</td>
<td>4.3678</td>
<td>73.793</td>
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<tr>
<td>Authorize</td>
<td>13.825</td>
<td>0.69124</td>
<td>85.484</td>
</tr>
<tr>
<td>Platform</td>
<td>1 answer</td>
<td>2 answer</td>
<td>3 answer</td>
</tr>
<tr>
<td>-------------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>Yahoo</td>
<td>5.2632</td>
<td>26.032</td>
<td>68.705</td>
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<tr>
<td>Blizzard</td>
<td>0.87449</td>
<td>13.632</td>
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<tr>
<td>Slashdot</td>
<td>5.7506</td>
<td>26.132</td>
<td>68.117</td>
</tr>
<tr>
<td>Skyrock</td>
<td>0.89514</td>
<td>11.995</td>
<td>87.11</td>
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<tr>
<td>Recaptcha</td>
<td>18.689</td>
<td>38.565</td>
<td>42.747</td>
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<tr>
<td>Microsoft</td>
<td>13.119</td>
<td>33.633</td>
<td>53.248</td>
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<tr>
<td>Mail.ru</td>
<td>24.388</td>
<td>41.004</td>
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</tr>
<tr>
<td>Google</td>
<td>7.8974</td>
<td>25.385</td>
<td>66.718</td>
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<td>1.9013</td>
<td>15.827</td>
<td>82.271</td>
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<tr>
<td>Digg</td>
<td>2.4745</td>
<td>19.031</td>
<td>78.495</td>
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<tr>
<td>captchas.net</td>
<td>7.9385</td>
<td>32.113</td>
<td>59.949</td>
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<tr>
<td>Baidu</td>
<td>2.7027</td>
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<td>80.978</td>
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<td>Authorize</td>
<td>0.23095</td>
<td>16.5178</td>
<td>93.251</td>
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</table>
## Nb of user distinct answer for audio scheme

<table>
<thead>
<tr>
<th>Service</th>
<th>1 answer</th>
<th>2 answer</th>
<th>3 answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yahoo</td>
<td>34.363</td>
<td>36.439</td>
<td>29.197</td>
</tr>
<tr>
<td>Slashdot</td>
<td>32.486</td>
<td>39.474</td>
<td>28.04</td>
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<tr>
<td>Recaptcha</td>
<td>7.8678</td>
<td>25.512</td>
<td>66.62</td>
</tr>
<tr>
<td>Microsoft</td>
<td>1.5264</td>
<td>10.823</td>
<td>87.65</td>
</tr>
<tr>
<td>Google</td>
<td>0.40965</td>
<td>4.1875</td>
<td>95.403</td>
</tr>
<tr>
<td>eBay</td>
<td>24.787</td>
<td>36.417</td>
<td>38.797</td>
</tr>
<tr>
<td>Digg</td>
<td>1.0129</td>
<td>12.615</td>
<td>86.372</td>
</tr>
<tr>
<td>Authorize</td>
<td>19.113</td>
<td>39.232</td>
<td>41.655</td>
</tr>
</tbody>
</table>
Image solving time

- authorize
- baidu
- captchas.net
- digg
- ebay
- google
- mailru
- mslive
- recaptcha
- skyrock
- slashdot
- blizzard
- yahoo
Audio solving time

- Authorize
- Digg
- eBay
- Google
- Microsoft
- Recaptcha
- Slashdot
- Yahoo
Accuracy by education

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Image captcha</th>
<th>Audio captcha</th>
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</thead>
<tbody>
<tr>
<td>Not formal</td>
<td>0.87</td>
<td>0.51</td>
</tr>
<tr>
<td>High School</td>
<td>0.88</td>
<td>0.54</td>
</tr>
<tr>
<td>Bachelor</td>
<td>0.88</td>
<td>0.52</td>
</tr>
<tr>
<td>Master</td>
<td>0.87</td>
<td>0.51</td>
</tr>
<tr>
<td>PhD</td>
<td>0.85</td>
<td>0.54</td>
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</tbody>
</table>
Solving time by education

- Solving time for image
- Solving time for audio

<table>
<thead>
<tr>
<th>Education</th>
<th>Not formal</th>
<th>High School</th>
<th>Bachelor</th>
<th>Master</th>
<th>Phd</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9.6</td>
<td>8.49</td>
<td>9.36</td>
<td>9.16</td>
<td>7.64</td>
</tr>
<tr>
<td></td>
<td>19.75</td>
<td>19.44</td>
<td>23.67</td>
<td>23.25</td>
<td>21.33</td>
</tr>
</tbody>
</table>

Seconds
Image captcha accuracy time by language

- **Native speakers**
  - Yahoo: 0.881
  - Blizzard: 0.928
  - Slashdot: 0.848
  - Skyrock: 0.925
  - Recaptha: 0.738
  - Microsoft: 0.804
  - Mail.ru: 0.700
  - Google: 0.861
  - eBay: 0.873
  - Digg: 0.867
  - captchas.net: 0.848
  - Baidu: 0.927
  - Authorize: 0.976

- **Non-Native speakers**
  - Yahoo: 0.874
  - Blizzard: 0.955
  - Slashdot: 0.890
  - Skyrock: 0.956
  - Recaptha: 0.772
  - Microsoft: 0.794
  - Mail.ru: 0.704
  - Google: 0.873
  - eBay: 0.935
  - Digg: 0.919
  - captchas.net: 0.925
  - Baidu: 0.928
  - Authorize: 0.979
Image captcha solving time by language

<table>
<thead>
<tr>
<th>Service</th>
<th>Native speakers</th>
<th>Non-native speakers</th>
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<tbody>
<tr>
<td>Yahoo</td>
<td>9.4</td>
<td>11.1</td>
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<tr>
<td>Blizzard</td>
<td>8.3</td>
<td>9.7</td>
</tr>
<tr>
<td>Slashdot</td>
<td>6.2</td>
<td>8.3</td>
</tr>
<tr>
<td>Skyrock</td>
<td>7.0</td>
<td>8.3</td>
</tr>
<tr>
<td>RecapTCHA</td>
<td>9.4</td>
<td>12.8</td>
</tr>
<tr>
<td>Microsoft</td>
<td>11.5</td>
<td>13.7</td>
</tr>
<tr>
<td>Mail.ru</td>
<td>11.1</td>
<td>13.5</td>
</tr>
<tr>
<td>Google</td>
<td>10.4</td>
<td>13.5</td>
</tr>
<tr>
<td>eBay</td>
<td>7.5</td>
<td>8.0</td>
</tr>
<tr>
<td>Digg</td>
<td>7.2</td>
<td>8.6</td>
</tr>
<tr>
<td>captchas.net</td>
<td>7.0</td>
<td>8.7</td>
</tr>
<tr>
<td>Baidu</td>
<td>7.4</td>
<td>6.3</td>
</tr>
<tr>
<td>Authorize</td>
<td>7.1</td>
<td>5.9</td>
</tr>
</tbody>
</table>
Audio captcha accuracy time by language

- Yahoo: Native speakers 0.67, Non-native speakers 0.71
- Slashdot: Native speakers 0.65, Non-native speakers 0.73
- Recaptcha: Native speakers 0.45, Non-native speakers 0.50
- Microsoft: Native speakers 0.39, Non-native speakers 0.37
- Google: Native speakers 0.35, Non-native speakers 0.35
- eBay: Native speakers 0.62, Non-native speakers 0.65
- Digg: Native speakers 0.39, Non-native speakers 0.37
- Authorize: Native speakers 0.57, Non-native speakers 0.63
Audio captcha solving time by language

- **Yahoo**
  - Native speakers: 25.00 seconds
  - Non-native speakers: 27.27 seconds

- **Slashdot**
  - Native speakers: 11.70 seconds
  - Non-native speakers: 18.39 seconds

- **Recaptcha**
  - Native speakers: 19.48 seconds
  - Non-native speakers: 30.63 seconds

- **Microsoft**
  - Native speakers: 16.63 seconds
  - Non-native speakers: 30.12 seconds

- **Google**
  - Native speakers: 33.21 seconds
  - Non-native speakers: 35.20 seconds

- **eBay**
  - Native speakers: 11.84 seconds
  - Non-native speakers: 14.49 seconds

- **Digg**
  - Native speakers: 14.83 seconds
  - Non-native speakers: 18.89 seconds

- **Authorize**
  - Native speakers: 11.94 seconds
  - Non-native speakers: 15.41 seconds

The chart shows the audio captcha solving time by language for various services, comparing native and non-native speakers.
Conclusion / ongoing work

- Captcha security rely on many different techniques
- Not clear how to design them well
- Ongoing work
  - What makes a captcha hard/slow for human?
  - What makes a captcha secure?
Features interactions

![3D graph showing features interactions with axes labeled Character size and Gap between character, and Time (ms) on the Z-axis. The graph displays various peaks and troughs indicating the interaction between character size and gap.]