CAPTCHAs:

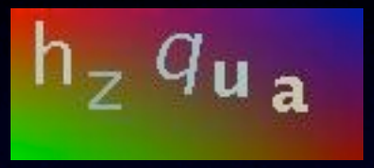
Are they really hopeless?

(Yes)

Completely
Automated
Public
Test to tell
Computers and
Humans
Apart

Why? Protect from automated abuse.

Examples


h z q u a


M 9 QK J 9


SPADSC


No premium user. Please enter all letters having a below.
LKOCI38


kantiveg


cyupwJ


WHITMAN

The Problem

- Really hard for a computer
- Hard for a person
- So they can't be too hard

CAPTCHA Breaking

- Is it worth it?
- $$ value per CAPTCHA solved
- Retooling Cost

Automation?

- Is automation worthwhile?
- CAPTCHA “Farms”
- How much do they really cost?
- Accuracy requirement?

Two Approaches

- Attack the implementation
- Attack the actual CAPTCHA (by solving it)

Implementation Issues

- Not enough server side state
  - Map request to token
    - Has token been used before?
- Problem:
  - Try to break more than once
  - Reuse solutions

Server State

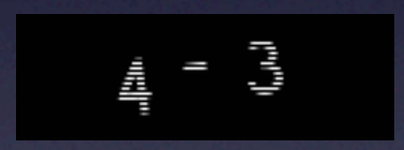
```
function ts_is_human($ts_random, $string) {
  global $ts_random, $site_key;
  $datekey = date("F j");
  $rcode = hexdec(md5($site_key . $ts_random
                                . $datekey));
  $code = substr($rcode, 2, 6);
  return $string==$code;
}
```

Source: http://coffelius.arabandalucia.com

Lousy Encoding

- CAPTCHA solution encoded in URL or form parameters

captcha_image.php?x=-8&y=20

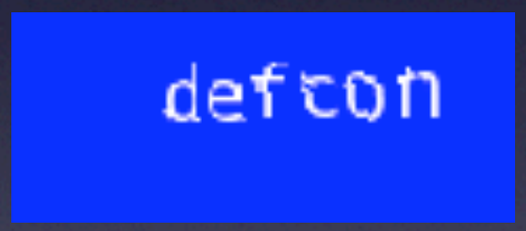



```
<input type="hidden" name="cap"
value="c4ca4238a0b923820dcc509a6f75849b">
```

Multiple Requests

- Different images for same CAPTCHA.
- Easy way to pump up accuracy.









Lousy RNG

- Most generators not secure
- Difficulty
  - Truncated output
  - Intermediate requests
  - Multiple servers
- Sleep easy. `md5(rand)`

Lousy RNG

Just for kicks, lets take a closer look.

```
function generate_code($len) {
  $code = '';
  for($i = 1; $i <= $len; $i++) {
    $code .= charset{rand(0, strlen(charset) - 1)};
  }
  return $code;
}
```

Source: http://www.phpcaptcha.org

PHP rand

```
PHPAPI long php_rand(TSRMLS_D) {
  long ret;
  if (!BG(rand_is_seeded))
    php_srand(GENERATE_SEED() TSRMLS_CC);

#ifdef ZTS
  ret = php_rand_r(&BG(rand_seed));
#else
# if defined(HAVE_RANDOM)
  ret = random();
# elif defined(HAVE_LRAND48)
  ret = lrand48();
# else
  ret = rand();
# endif
#endif
  return ret;
}
```

random()?

man random

The random() function uses a non-linear additive feedback random number generator employing a default table of size 31 long integers to return successive pseudo-random numbers in the range from 0 to (2**31)-1.

random.c

The random number generation technique is a linear feedback shift register approach, employing trinomials (since there are fewer terms to sum up that way).

For More...

[1] A. Joux and J. Stern, "Lattice Reduction: A Toolbox for the Cryptanalyst," Journal of Cryptology, vol. 11, Nov. 1998, pp. 161-185.

[2] A.M. Frieze et al., "Reconstructing Truncated Integer Variables Satisfying Linear Congruences," SIAM Journal on Computing, vol. 17, Apr. 1988, pp. 262-280.

[3] A. Frieze, R. Kannan, and J. Lagarias, "Linear Congruential Generators Do Not Produce Random Sequences," Foundations of Computer Science, 1984. 25th Annual Symposium on, 1984, pp. 480-484.

Breaking CAPTCHA

- Recovering perl programmer ⇒ Lazy
- Off the shelf technology?
  - tesseract
  - jocr
  - ocrad
  - etc.

General Approach

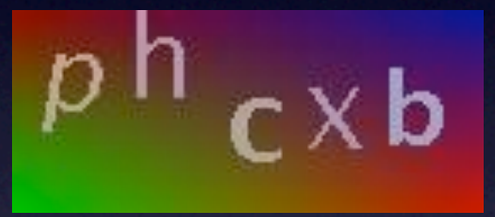
- Use OCR engines as black box
- Additional pre / post processing to improve performance

Image Processing

- Remove / smooth noise
- Automate
  - PIL
  - ImageMagick
- Doesn't add data, just makes more suitable for OCR engine.

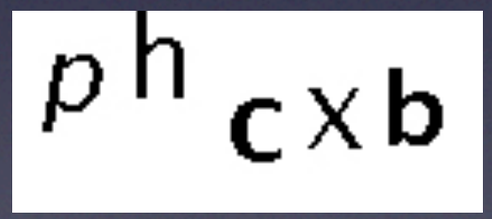
Image Processing

Initial





Processed





Training Sets

- OCR engines need to be trained for particular fonts / styles
- Training can be automated
  - Use LaTeX, etc to generate data
  - Use actual CAPTCHA data

Other Strategies

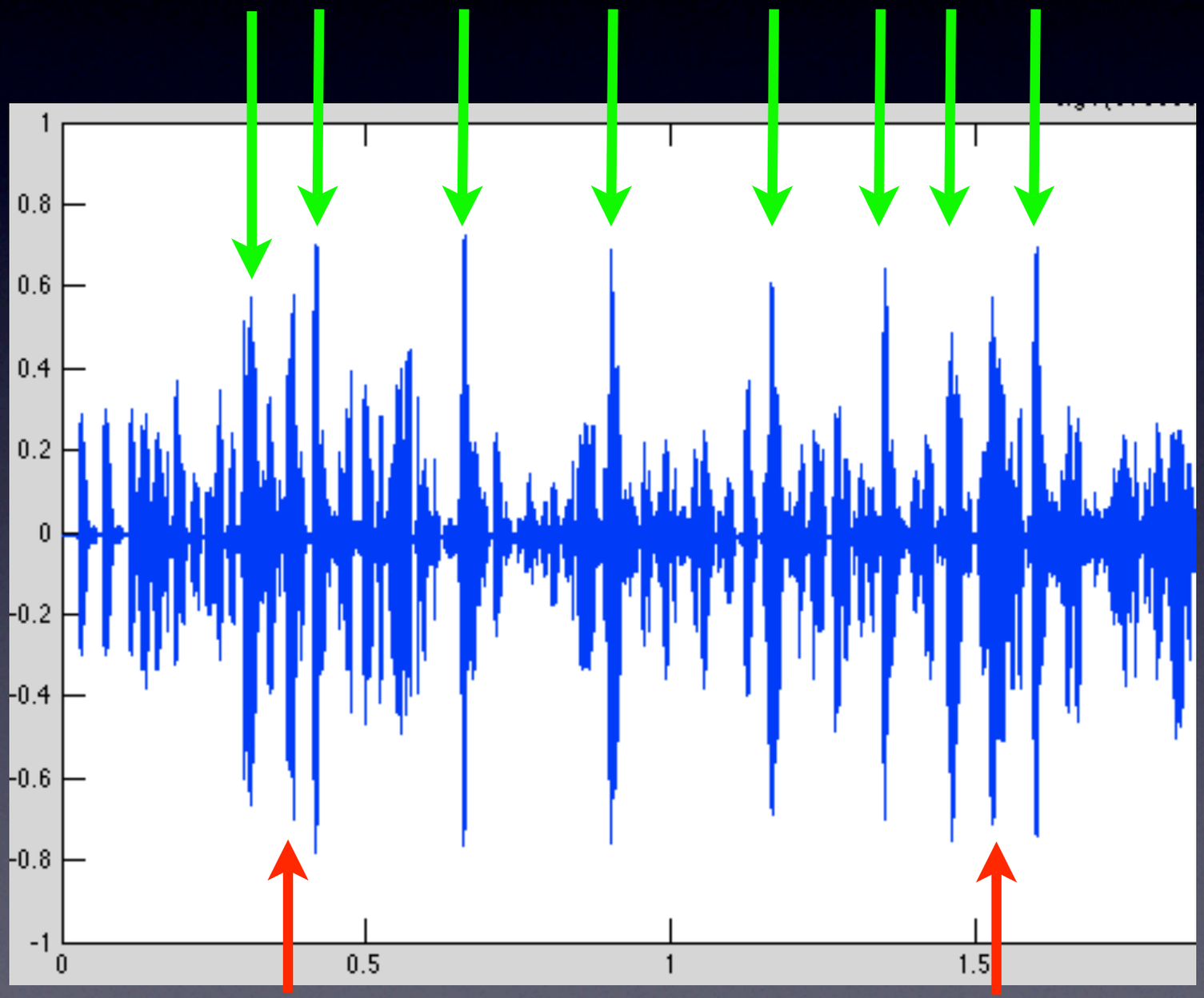
- Attacking Audio CAPTCHAs
- Advantages?
  - Only one dimension
  - Frequency domain more intuitive
  - Less room for noise

Audio

- Time Domain

Time Domain

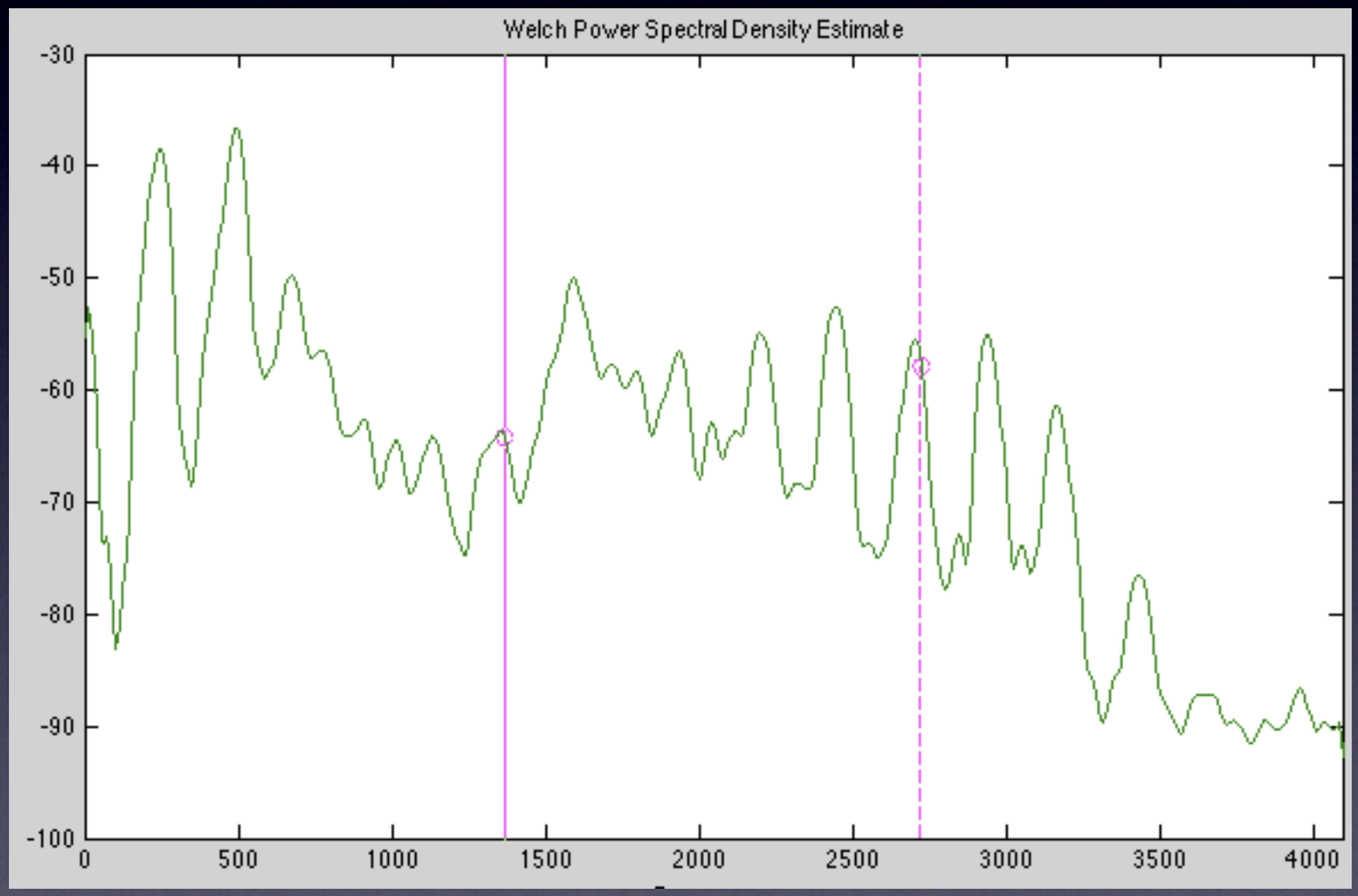
Guess where the numbers are?



Audio

- Frequency Domain
- Fourier Transform
  - Decompose (almost) any function in terms of complex exponentials
- Perform frequency level filtering
- More intuitive for sound than image

Power Spectral Density



[demos here]

What to do?

- Integrate cultural knowledge based on userbase.
- Hot or not CAPTCHA
- Cats vs. Dogs

Bourbon or Scotch?











