Which Malware Lures Work Best?

Measurements from a Large Instant Messaging Worm

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Outline

- The “Yimfoca” instant messaging worm
- The impact of shorteners
- The impact of Portuguese

In the beginning (late April 2010)

- April 30: Reports of a new Instant Messenger worm start to circulate on Romanian web forums, affects Yahoo Instant Messenger and (the interconnected) Windows Live Messenger
- Message from buddy says:
  - foto ☺ http://example.com/image.php?user@email.example.com
- The recipient clicks and (if OKs a pop-up) is infected
  - sees a generic MySpace page to reduce suspicion
- Malware shipped to Symantec May 6th who name it “Yimfoca” and arrange for its detection
  - name from “Yahoo!” “IM” “infocard.exe”
  - probably a Rimekud variant (and rather boring)
- May 6: takedown of some (Symantec identified) C&C

Finding out how Yimfoca works

- Ran in VMware: DNS traffic and IRC traffic were captured.
  - resolved a hostname to locate IRC server
  - connected to this IRC server & joined channel #jakarta
  - topic of this channel was "foto ☺ http://malwareurl"
  - occasionally forced to join #mix or #!l! to download new code
- If connection to C&C failed backup hostnames were used
- Refreshing the channel topic caused malware to send out message to buddies (filling in the email address from the local machine's IM address book)
- To monitor what was going on I created a Perl "bot" to emulate compromised machine, to camp on channel(s) of the multiple IRC servers and record traffic...

Example IRC traffic (26 May: farqebook)

```
13:51:06 wd74!wd74@uNkn0wn.eu TOPIC #jakarta :.m.s|.m.e foto :D http://farqebook.com/photos.php?=
14:04:25 wd74!wd74@uNkn0wn.eu TOPIC #jakarta :.m.s|.m.e foto :D http://farqebook.com/photos.php?=
14:17:46 wd74!wd74@uNkn0wn.eu TOPIC #jakarta :.m.s|.m.e foto :D http://farqebook.com/photos.php?=
14:31:06 wd74!wd74@uNkn0wn.eu TOPIC #jakarta :.m.s|.m.e foto :D http://farqebook.com/photos.php?=
14:44:26 wd74!wd74@uNkn0wn.eu TOPIC #jakarta :.m.s|.m.e foto :D http://farqebook.com/photos.php?=
14:57:46 wd74!wd74@uNkn0wn.eu TOPIC #jakarta :.m.s|.m.e foto :D http://farqebook.com/photos.php?=
15:04:59 irc.priv8net.com MODE #jakarta +o msg
15:11:06 wd74!wd74@uNkn0wn.eu TOPIC #jakarta :.m.s|.m.e foto :D http://farqebook.com/photos.php?=
15:24:28 wd74!wd74@uNkn0wn.eu TOPIC #jakarta :.m.s|.m.e foto :D http://farqebook.com/photos.php?=
16:17:26 wd56!wd56@uNkn0wn.eu TOPIC #jakarta :.m.s|.m.e foto :D http://farqebook.com/photos.php?=
16:30:46 wd56!wd56@uNkn0wn.eu TOPIC #jakarta :.m.s|.m.e foto :D http://farqebook.com/photos.php?=
16:44:08 wd56!wd56@uNkn0wn.eu TOPIC #jakarta :.m.s|.m.e foto :D http://farqebook.com/photos.php?=
16:57:28 wd56!wd56@uNkn0wn.eu TOPIC #jakarta :.m.s|.m.e foto :D http://farqebook.com/photos.php?=
17:10:48 wd56!wd56@uNkn0wn.eu TOPIC #jakarta :.m.s|.m.e foto :D http://farqebook.com/photos.php?=
```

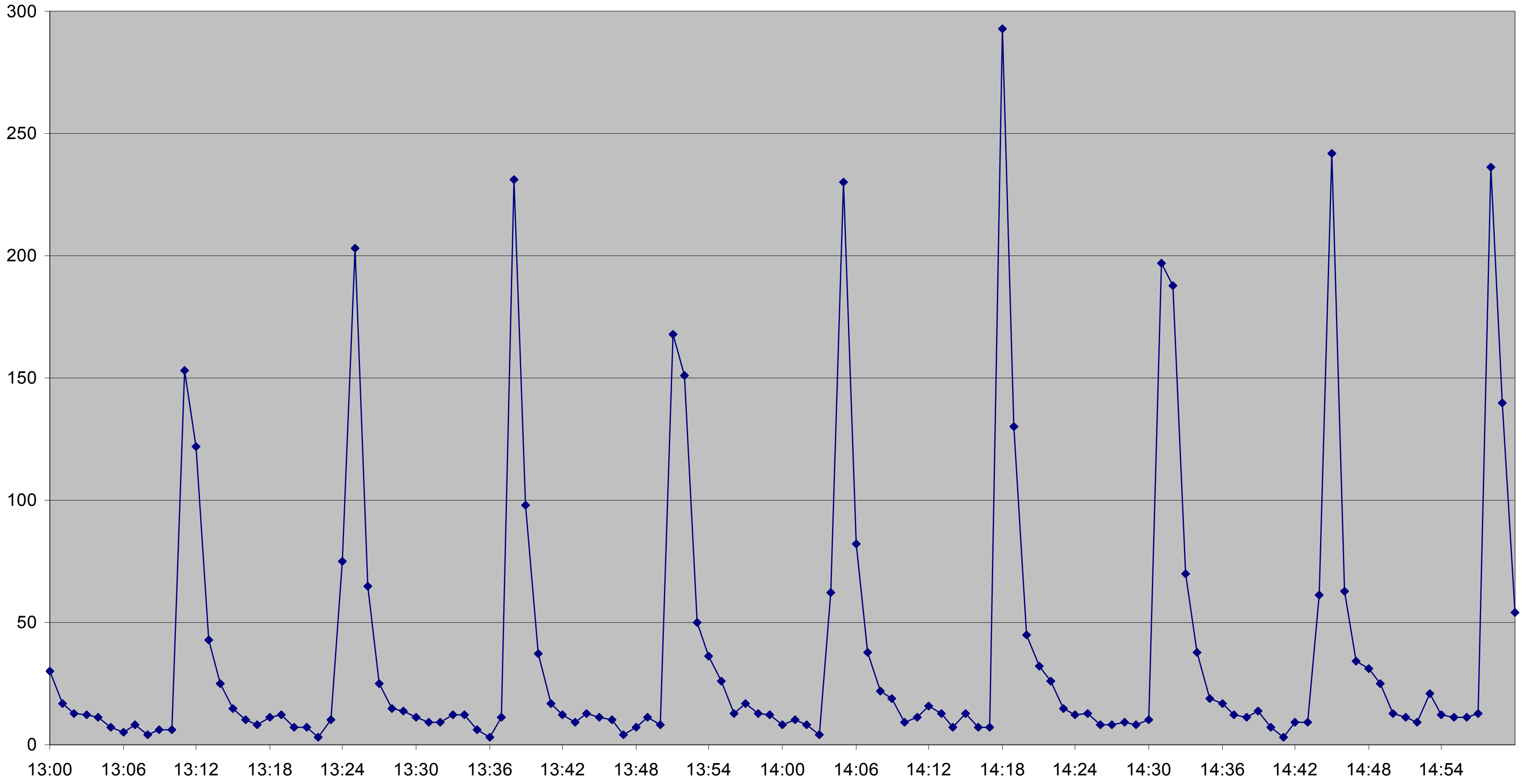
Apache logs

- Turned out the criminals were, more often than not, hosting the malware at a hosting site with world-readable weblogs
- So we were able to inspect logs and determine activity
- We could even identify the machine from which they were monitoring that the malware was still present
- Other activity from the same machine showed 5 different browser identification strings (some 32bit some 64bit) which may indicate size of the "gang"
- Logs also gave us a reliable measure of the click-through rate
- NB: not (quite) the infection rate

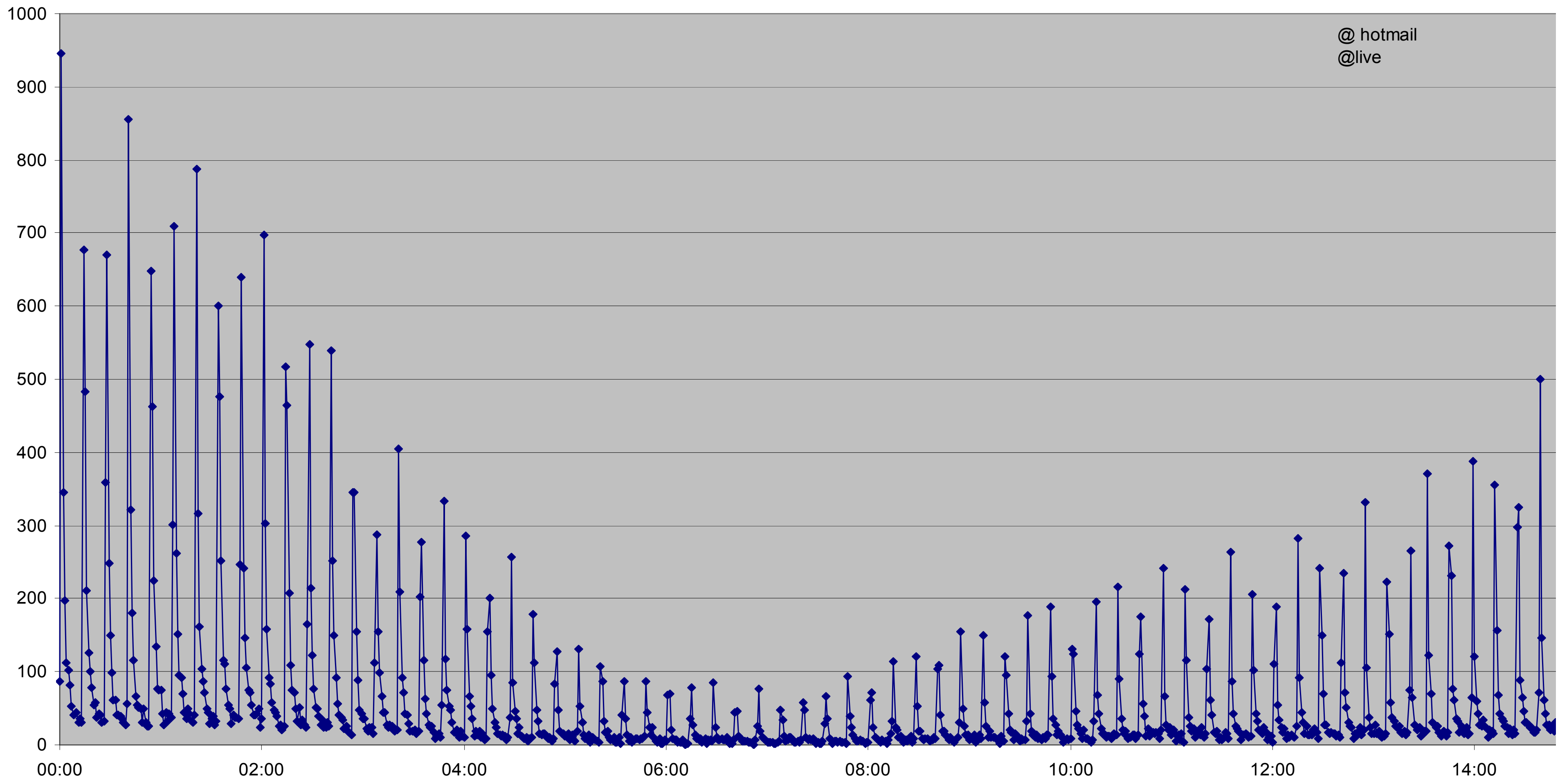
Also able to tell *who* was clicking

- The URL was (by this time) generally of the form
    - http://example.com/photo.php?your.email@hotmail.com
- Email addresses being extracted from Microsoft IM client
    - hence could count Microsoft customer infections
    - no email address assumed to be Yahoo! infecting Yahoo!
    - addresses of the form yahoo:email@yahoo.com were result of Microsoft customers whose Yahoo! IM buddies had clicked...
- Yahoo was blocking (failing to deliver) the worm messages
    - since URL rapidly changed, an automated system was used
- Charted numbers from the logging
    - clearly running riot on Microsoft platform
    - showed how effective Yahoo! blocking was

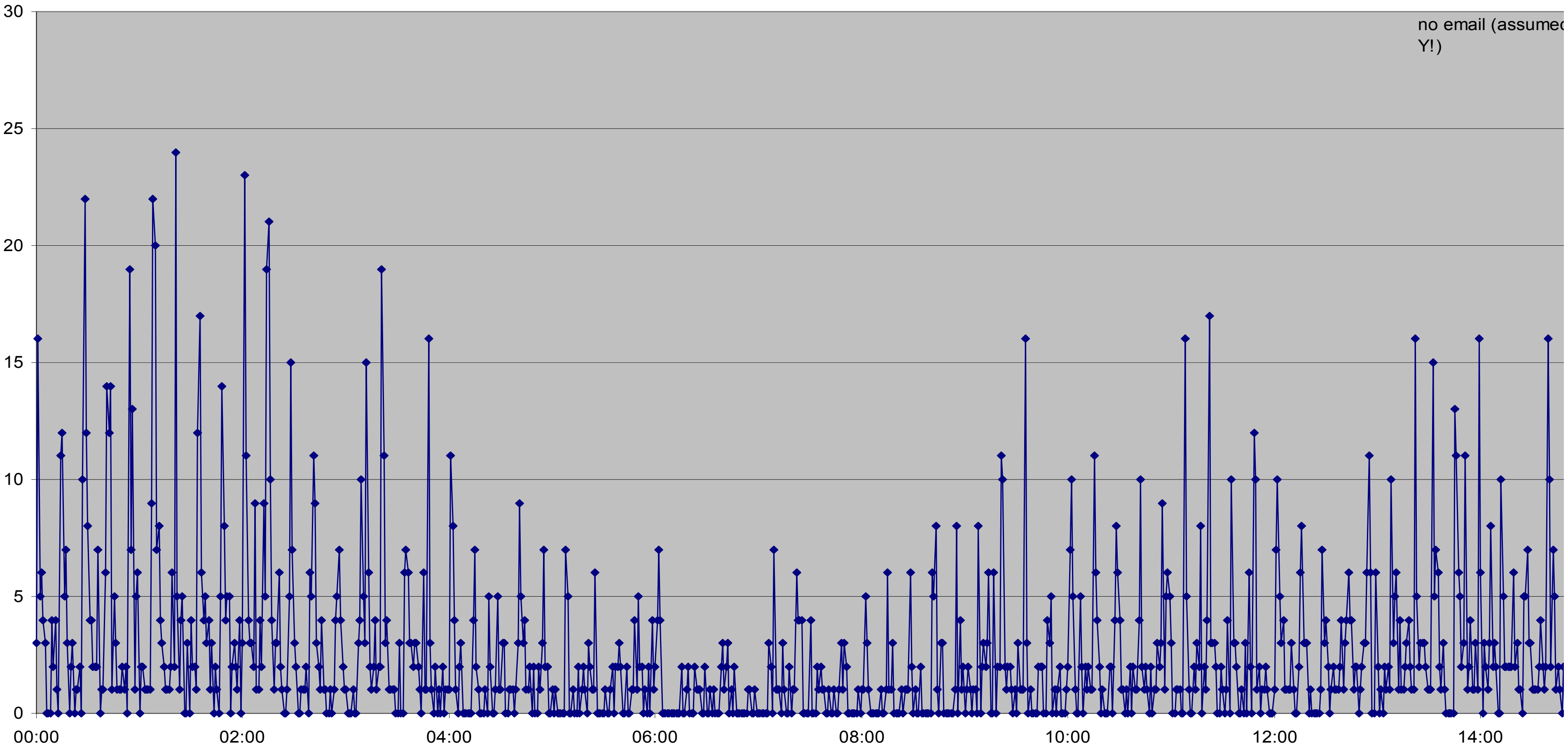
27 May, MS infections



Data from 30 May (@microsoft emails)



Data from 30 May (blank => yahoo)



Starting the take-down

- We now understood how to disable Yimfoca
  - suspend **<u>ALL</u>** the hostnames used to locate IRC servers
  - NB: knowledge of alternative names & “Plan B” crucial
  - disable the IRC servers
  - NB: both ought to be done “at the same time”
- So, we did !
- By June 17th all hostnames were suspended and all IRC servers (apparently hacked machines) were disabled (and the machines properly secured)

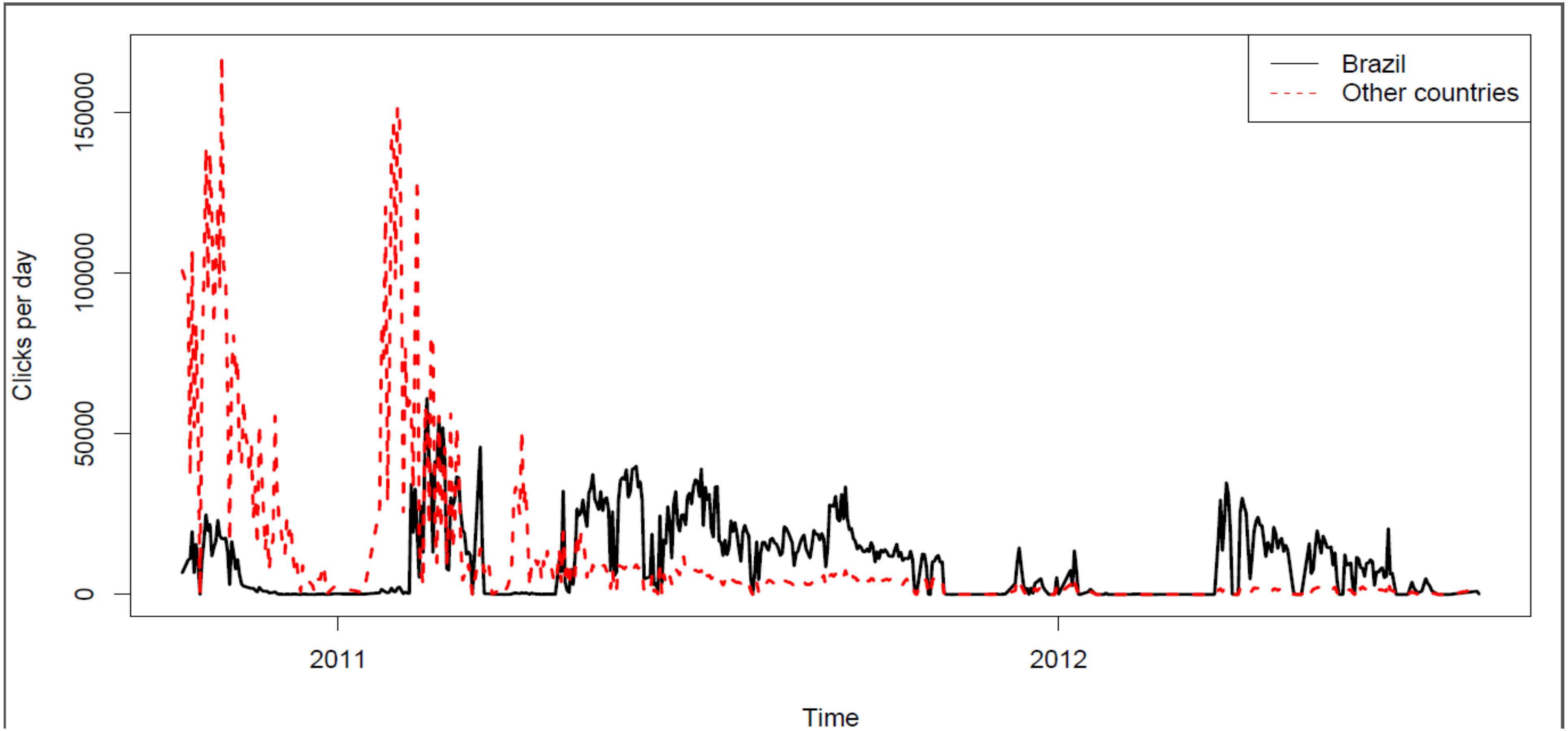
Meanwhile...

- Further analysis of our virus samples from May showed us not all of them were actually the “Yimfoca” we now understood
- Also further analysis of the blocked message logs showed:
  - various two year-old worms still broadcasting (fixed URLs and the malware was long gone)
  - three Yimfoca variants
- So we decided to take down the three variants, since they had the same (ultra-effective) “foto ☺” lure, and because frankly they looked straightforward to tackle
- They were straightforward and all were down by 22nd June
- So we won...

Instant messenger worms (Part II)

- Similar worms start being deployed in Summer 2010
- Yahoo’s blocking system works very well
- Microsoft’s blocking system doesn’t
- The new worm also spreads on the Facebook IM platform (they do moderately well…)
- But in Spring 2011 the worms switched to using shorteners
- Every 13 minutes they have a new URL
- Yahoo’s blocking system fails to cope
- Another round of takedowns June 2011 ….
- … resurrected (again) in Brazil and drifts on into 2012
- THE END (??)

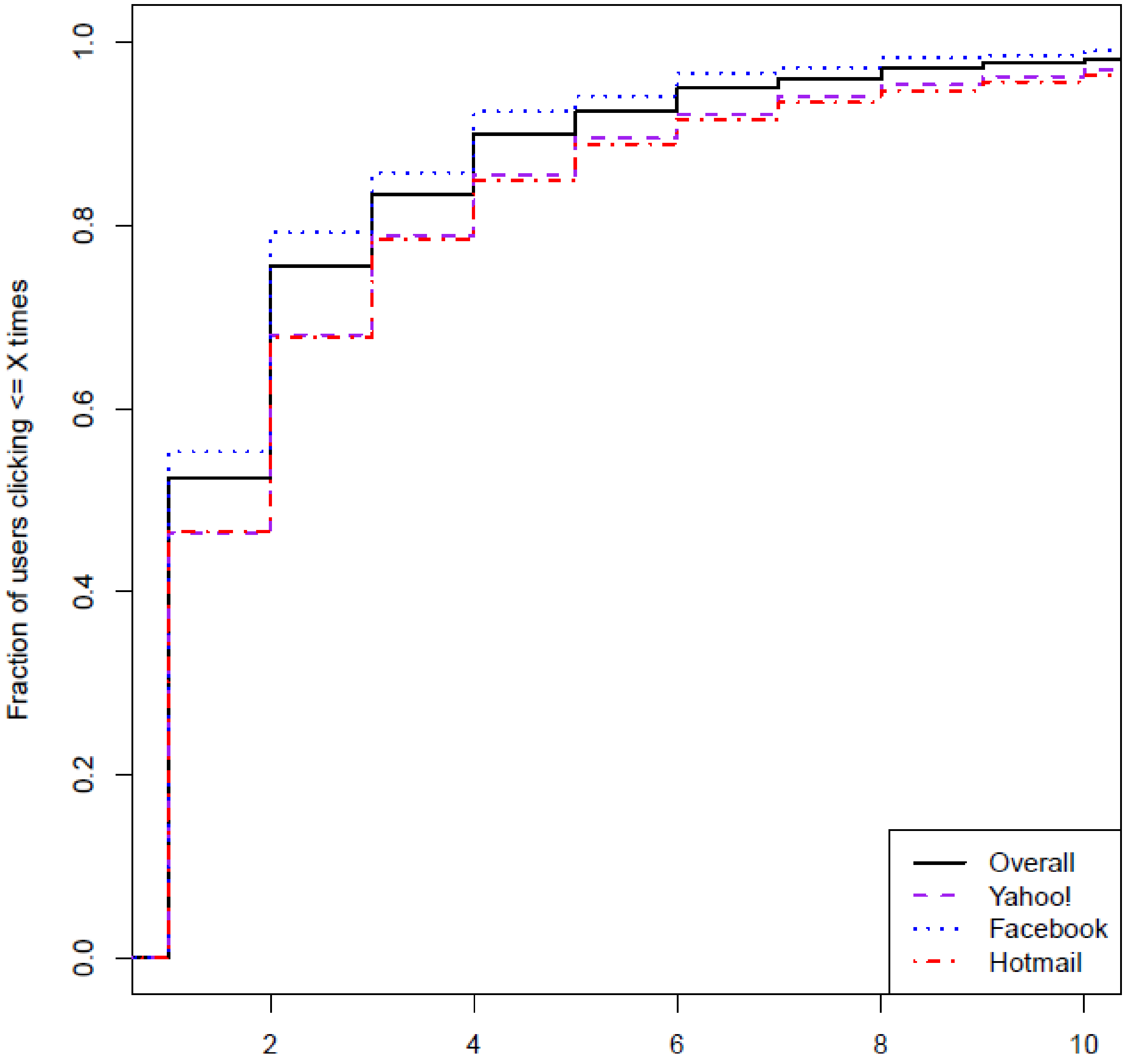
Brazilian victims



Estimating how many infected

- We have extensive web server logs
- We exclude AV vendors, Yahoo, Facebook etc.
  - Facebook is downloading in parallel to assess nature of URL
- We also exclude multiple clicks by same IP
  - analysis of this shows Facebook’s protection had some impact
- For all worms (to Aug 2012) this gave us 14 million “real” clicks
  - from original dataset of 63 million downloads
- BUT this is click rates, maybe people didn’t click OK or had AV…
  - but AV generally didn’t detect this at the time of download
  - and we think most people would click through the warning…

Number of clicks per user



Identifying infections

- Recall the #!l! channel for software update. My Perl bot joined this channel on each new IRC server
  - turned out that I was first to join the channel on some new servers and so I was chanop
- So I have a record of activity!

```
20:49:37 wd63!wd63@uNkn0wn.eu TOPIC #jakarta :.s|.m.s|.m.e Foto :D http://f-myspace.net/profile.php?=
21:01:03 [TUR|XP]2643895!6505@AECBF337.60FB0797.B0379ED3.IP JOIN :#!l!
21:01:04 [TUR|VIS]7412807!8824@A0EC43C1.9C986619.FA7C5148.IP JOIN :#!l!
21:01:04 [COL|XP]8048722!4192@0wn3d-37854CC6.dsl.intelnet.net.gt JOIN :#!l!
21:01:04 [FRA|XP]0325668!5702@0wn3d-12199A95.w90-56.abo.wanadoo.fr JOIN :#!l!
21:01:04 n[USA|XP]8824866!8631@0wn3d-5B781FDF.dyn.optonline.net JOIN :#!l!
21:01:04 [FRA|XP]7843135!1927@1FC1DD4F.7CDF4AF6.BB45ADBE.IP JOIN :#!l!
21:01:04 [DEU|XP]1690675!0013@0wn3d-1691EC12.dip.t-dialin.netJOIN :#!l!
21:01:04 [BRA|XP]0026510!1847@DC4BA7FD.F279DEBE.5053F232.IP JOIN :#!l!
```

Estimating the infection rate

- 2010-06-04 04:54:27 to 15:15:44 UTC
  - Perl program was chanop : and 17779 machines joined the channel
- For the same period we have web logs
  - 18720 unique downloads of the malware
- Hence infection rate is 95.0%
  - that is – people ARE clicking through the warning

Total infection numbers

- Estimates from daily rates, and messages ...
  - 27 May – 22 Jun = 36000 minutes
  - we have web log data from 40.7% of this time
- The de-duplicated number of clicks is 717 083
- Hence 1.67 million infected machines
  - perhaps 20% -- 80% higher because no diurnal adjustment
- Recall that when we were chanop we saw 1717/hour
- The overall rate is 2577/hour
- But worms grow exponentially (at least for a while) and note that we have no data for late April to end of May
  - so 1717:2577 disparity not implausible
- We estimate more than 3 million machines infected

Now some human factors research...

Phishing URLs (barclays is just an e.g.!)

1. www.barklays.com/login.html
2. www.barclays.com.account.1234567.kjakjas.info/login.html
3. www.kjakjas.info/www.barclays.com/login.html
4. www.kjakjas.info/~user/www.barclays.com/login.html
5. www.kjakjas.info/joomla/images/www.barclays.com/login.html
6. www.barclays.com.verysecure.com/login.html

Some special (ancient) cases

- http://www.barclays.com:security@www.kjakjas.info/login.html
  - disallowed by Microsoft (for HTTP) in Feb 2004
- http://www.barclays.com. ⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂ ⌂⌂⌂ ⌂⌂⌂ ⌂⌂⌂ ⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂⌂kjakjas.info/login.html
  - changes made to browser display c 2005

Does the bank name matter?

- Can be trivially obscured:

```
<a href="http://www.example.com">www.barclays.com</a>
```

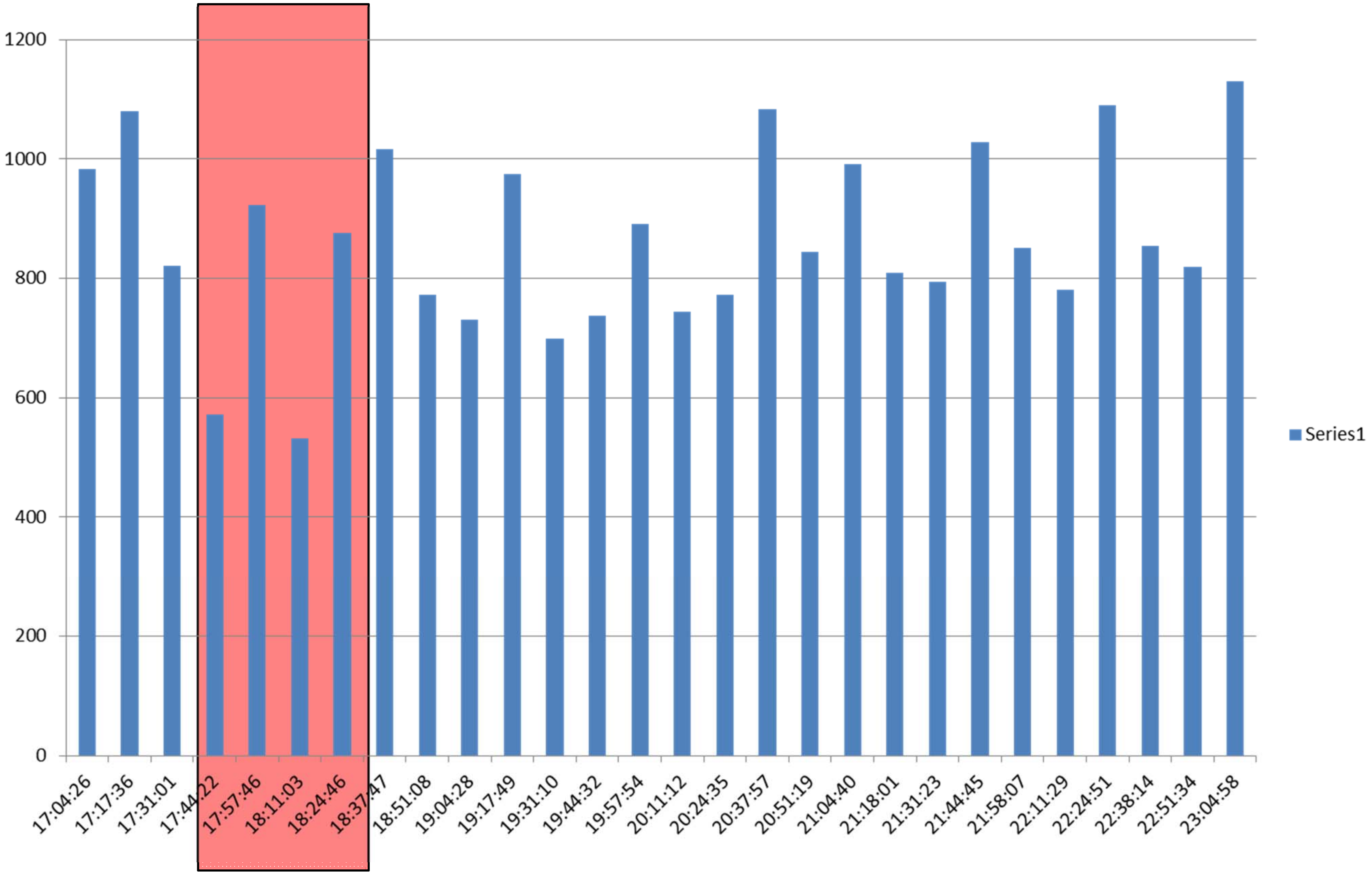
- Clearly the continued use of the bankname is thought to be useful – but it's hard to measure, the widespread use of "kits" means that the kit builder makes the decision for the phisher
- One datapoint is that online game phishing is heavily domain name based:

`eu-batt1e-gm-wow.com, eu-batt1e-gm-wow.net, eu-batt1e-gmwow.com, eu-batt1e-gmwow.net, eu-batt1e-wow-gm.net, eu-batt1e-wowgm.com, eu-batt1e-wowgm.net, eu-battle-bizzgm.com, eu-battle-bizzgm.net, eu-battle-eugm.net, eu-battle-wowgm.com, eu-battlegm-wow.com, eu-battlegm-wow.net, eu-battlegm-wow.org`

But sometimes URL shorteners are used

```
2011-02-17 17:04:26 is this you on pic? http://kunfacebook.net/album.php?=
2011-02-17 17:17:36 is this you on pic? http://kunfacebook.net/album.php?=
2011-02-17 17:31:01 is this you? http://kunfacebook.net/album.php?=
2011-02-17 17:44:22 is this you? http://linkmenow.org/images555?=
2011-02-17 17:57:46 is this you? http://linkmenow.org/images555?=
2011-02-17 18:11:03 is this you? http://linkmenow.org/images555?=
2011-02-17 18:24:46 is this you? http://linkmenow.org/images555?=
2011-02-17 18:37:47 is this you? http://kunfacebook.net/album.php?=
2011-02-17 18:51:08 is this you? http://kunfacebook.net/album.php?=
2011-02-17 19:04:28 is this you? http://kunfacebook.net/album.php?=
2011-02-17 19:17:49 is this you? http://kunfacebook.net/album.php?=
2011-02-17 19:31:10 is this you? http://kunfacebook.net/album.php?=
2011-02-17 19:44:32 is this you? http://kunfacebook.net/album.php?=
2011-02-17 19:57:54 is this you? http://kunfacebook.net/album.php?=
2011-02-17 20:11:12 is this you? http://kunfacebook.net/album.php?=
```

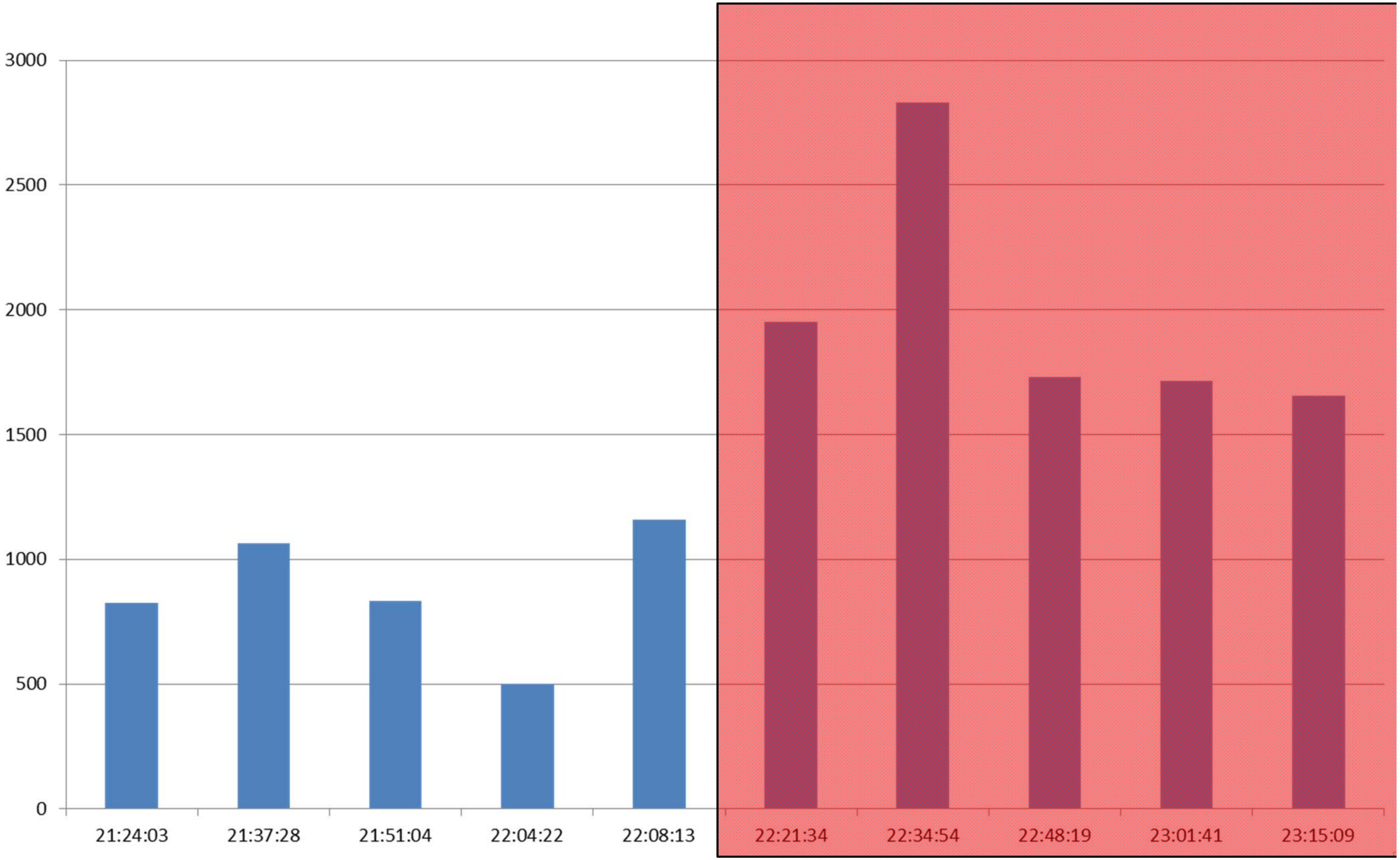
Some impact on clicks



Another example

```
2011-02-14 21:24:03 Foto :D http://fogz.eu/images886?=
2011-02-14 21:37:28 Foto :D http://fogz.eu/images886?=
2011-02-14 21:51:04
2011-02-14 22:04:22
2011-02-14 22:08:13 Foto :D http://fogz.eu/images91?=
2011-02-14 22:21:34 Foto :D http://justinloveis.net/album.php?=
2011-02-14 22:34:54 Foto :D http://justinloveis.net/album.php?=
2011-02-14 22:48:19 Foto :D http://justinloveis.net/album.php?=
2011-02-14 23:01:41
2011-02-14 23:15:09 Foto :D http://justinloveis.net/album.php?=
2011-02-14 23:28:27 Foto :D http://justinloveis.net/album.php?=
```

justinloveis works better than fogz.eu



Comparing domains (Feb-Apr 2011)

	Facebook	Myspace	Other	Shorteners
#domains	13	1	65	18
#visitors (total)	144748	11373	956962	424039
#visitors/site (median)	11905	11373	11092	2851
#downloads /min (mean)	22	45	16	10
#download /min (median)	6	45	11	3
Normalised rate (mean)	16	32	14	9
Normalised rate (median)	16	32	11	3

Comparing domains (Aug-Oct 2011)

	Facebook	Orkut
#domains	51	40
#visitors (total)	156823	140342
#visitors/site (median)	2991	3142
#downloads /min (mean)	7.4	6.8
#download /min (median)	3.9	3.9
Normalised rate (mean)	6.8	5.2
Normalised rate (median)	4.7	3.0

Language independent lures

- English 2.1%

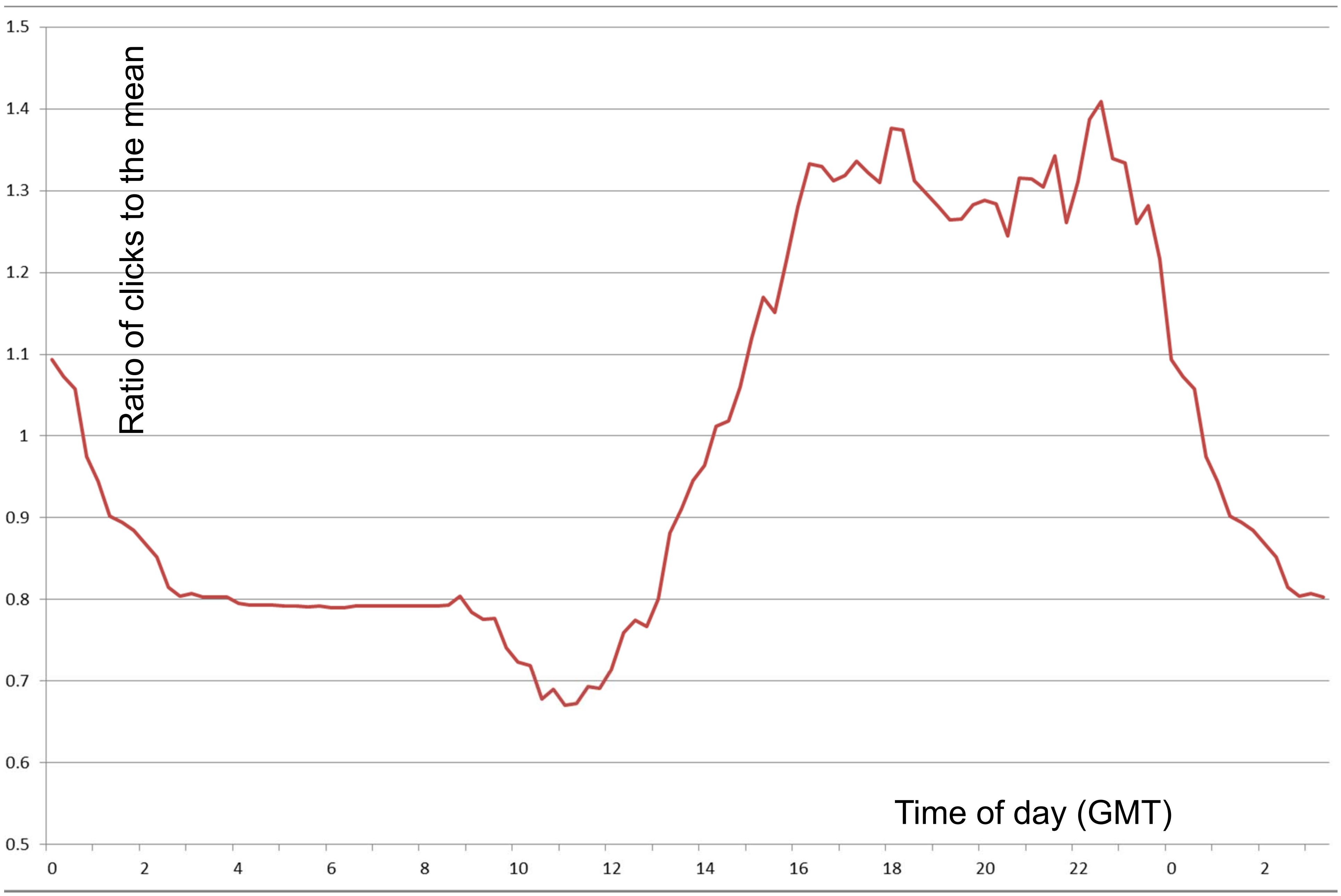
  `is this you?`

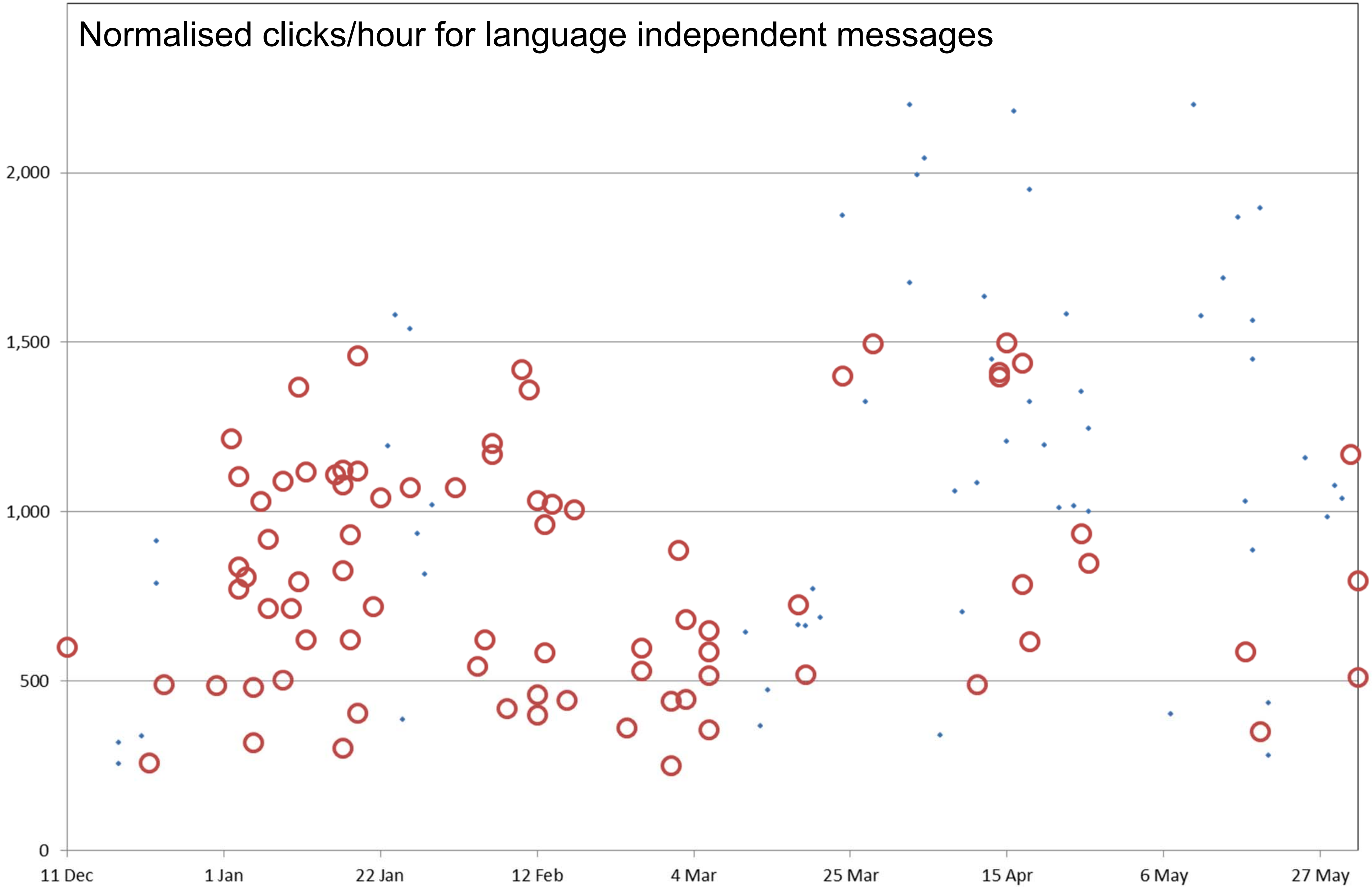
- Portuguese 48.0%

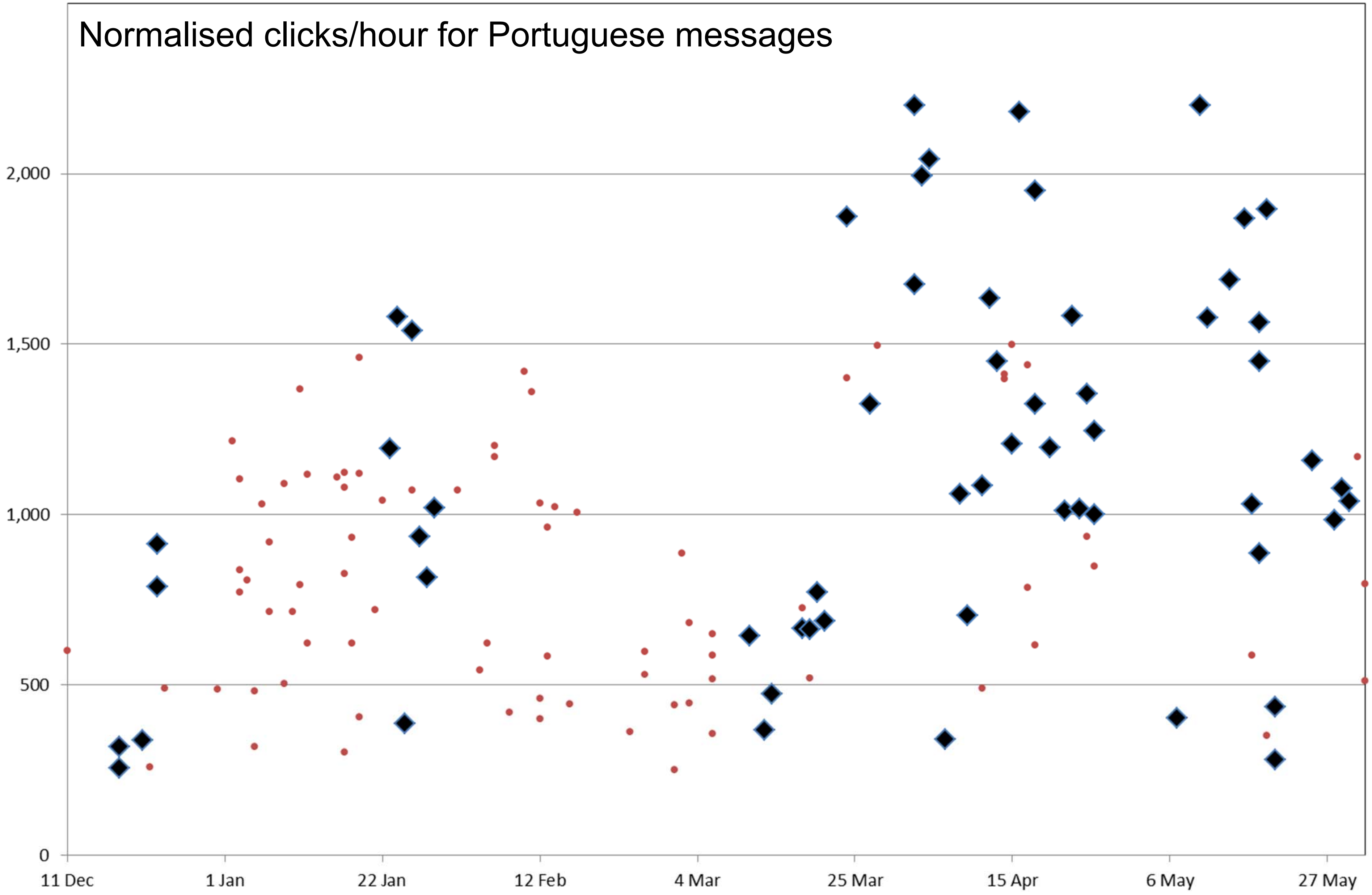
  `eu acho que  é você na`

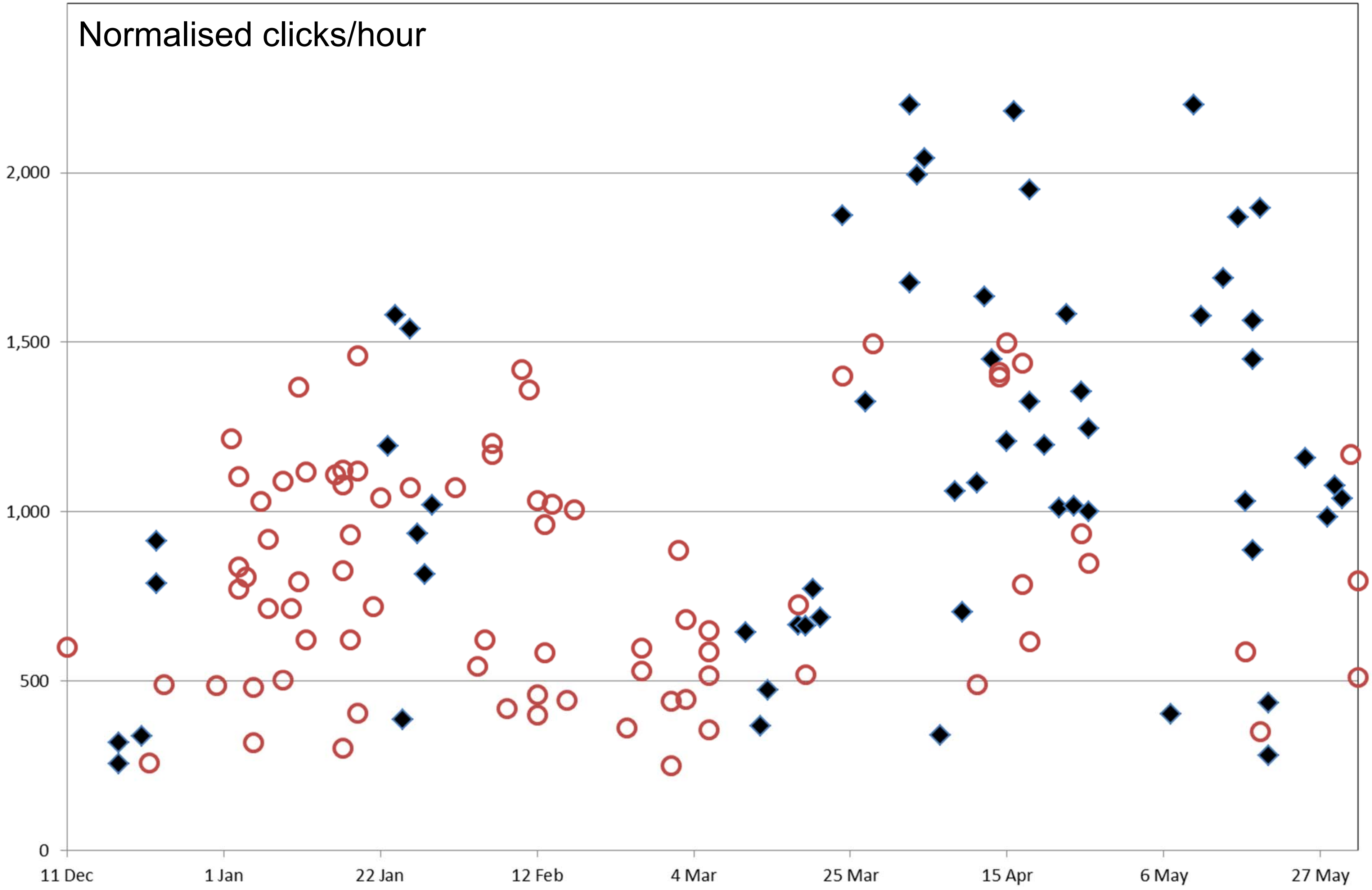
- Language independent 49.9%

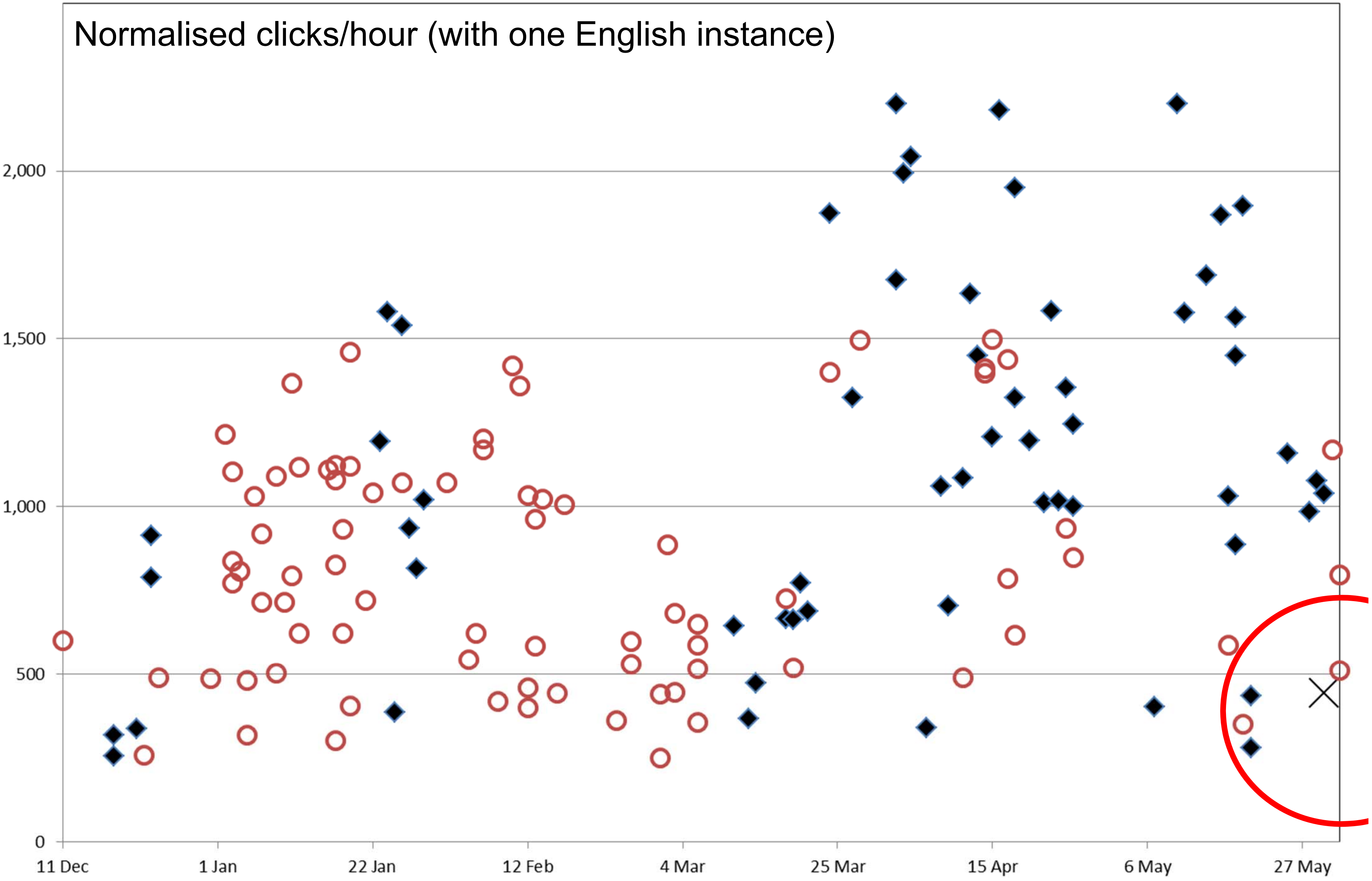
  `hahha foto`

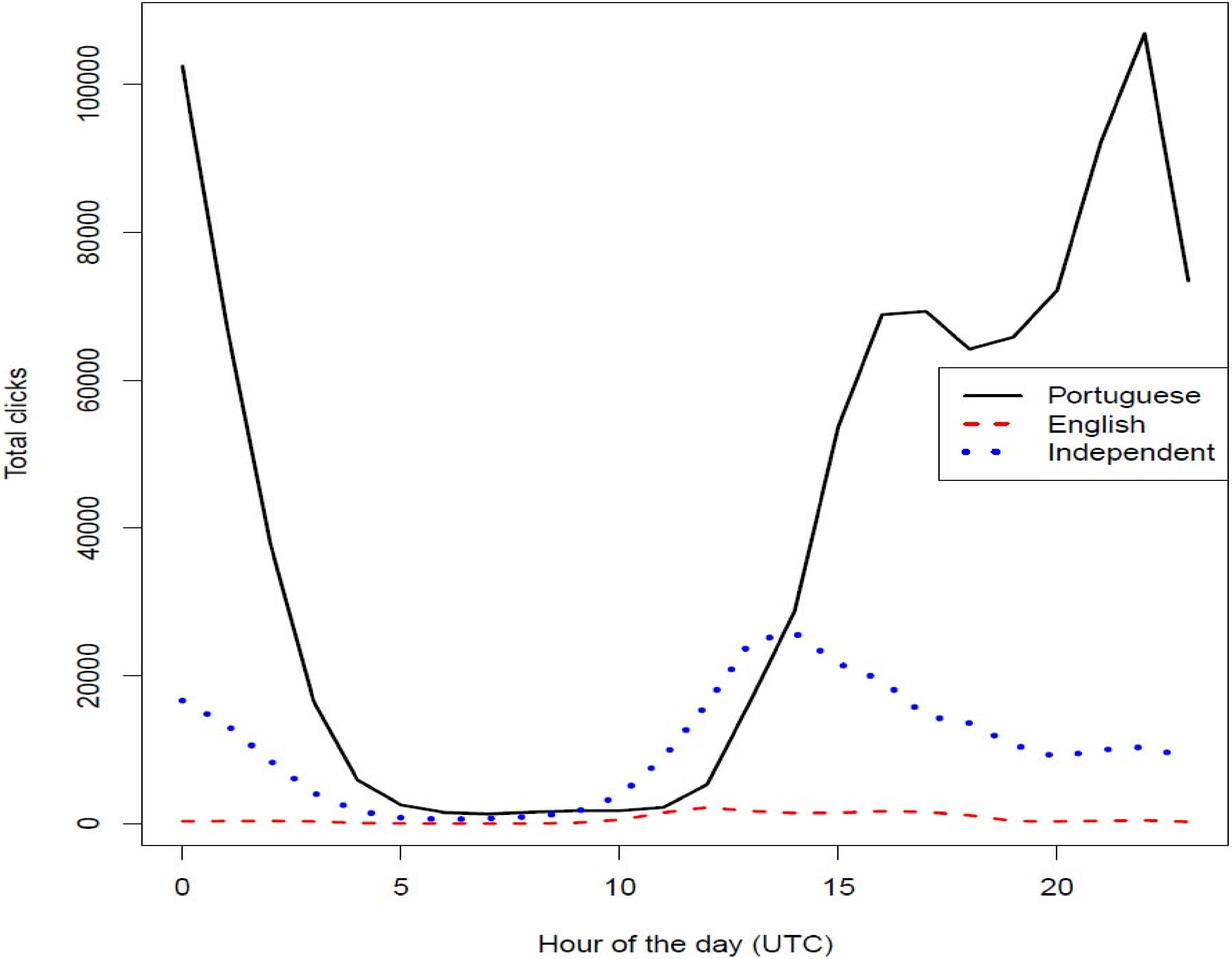

Ratio of clicks to the mean
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0
2
4
6
8
10
12
14
16
18
20
22
0
2
Time of day (GMT)


Normalised clicks/hour for language independent messages
2,000
1,500
1,000
500
0
11 Dec
1 Jan
22 Jan
12 Feb
4 Mar
25 Mar
15 Apr
6 May
27 May


Normalised clicks/hour for Portuguese messages
2,000
1,500
1,000
500
0
11 Dec
1 Jan
22 Jan
12 Feb
4 Mar
25 Mar
15 Apr
6 May
27 May

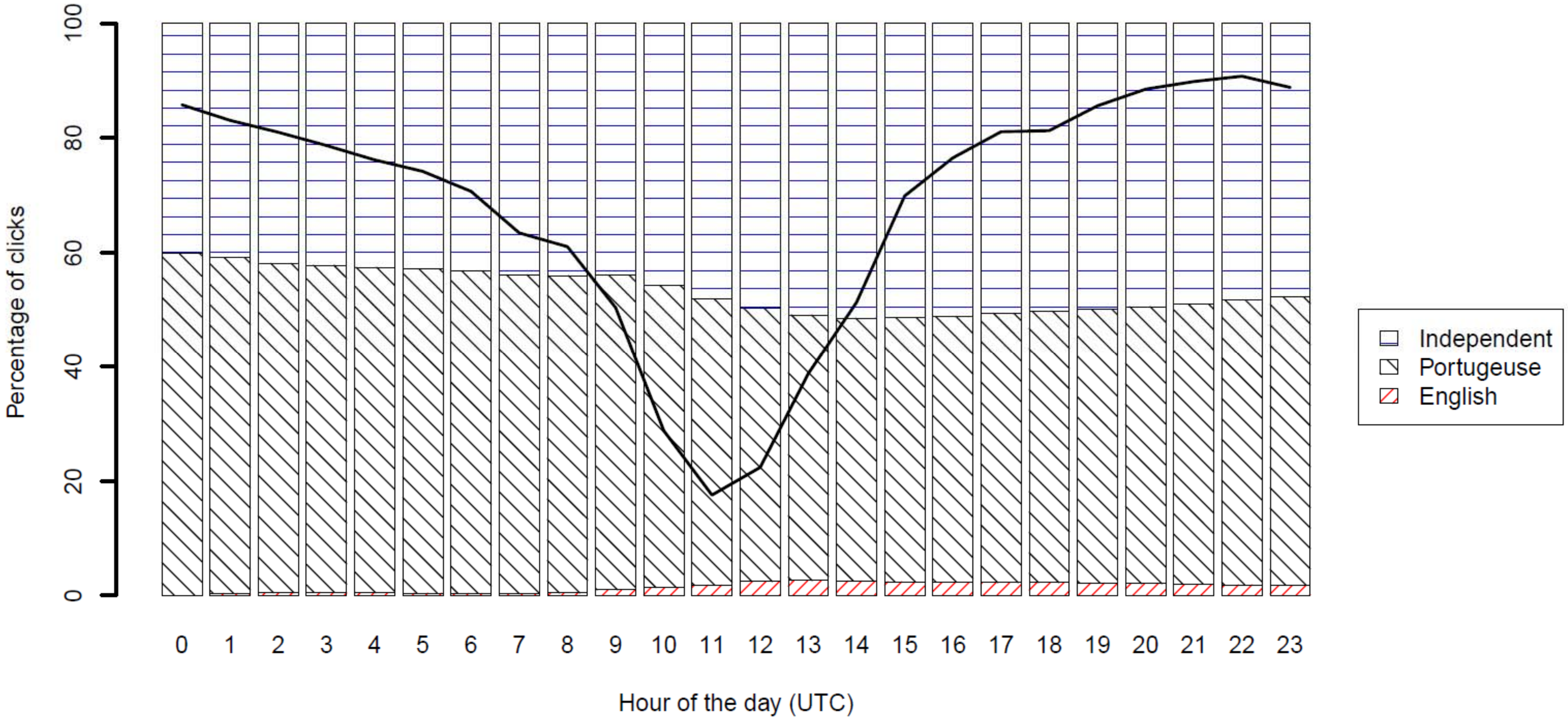

Normalised clicks/hour
2,000
1,500
1,000
500
0
11 Dec
1 Jan
22 Jan
12 Feb
4 Mar
25 Mar
15 Apr
6 May
27 May


Normalised clicks/hour (with one English instance)
2,000
1,500
1,000
500
0
11 Dec
1 Jan
22 Jan
12 Feb
4 Mar
25 Mar
15 Apr
6 May
27 May



Total clicks
0
20000
40000
60000
80000
100000
0
5
10
15
20
Hour of the day (UTC)
Portuguese
English
Independent

The effect is real !



Superimposed line is clicks on Portuguese lures

Conclusions

- Some fairly simple lures and some low-tech IRC servers will allow you to build a multi-million machine botnet
- People really do click OK without reading what the warning message says
- Shorteners are not as attractive as domain names and are clicked rather less
- When criminals communicate with Brazilians in Portuguese this increases the likelihood of foolish events occurring

http://www.lightbluetouchpaper.org

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