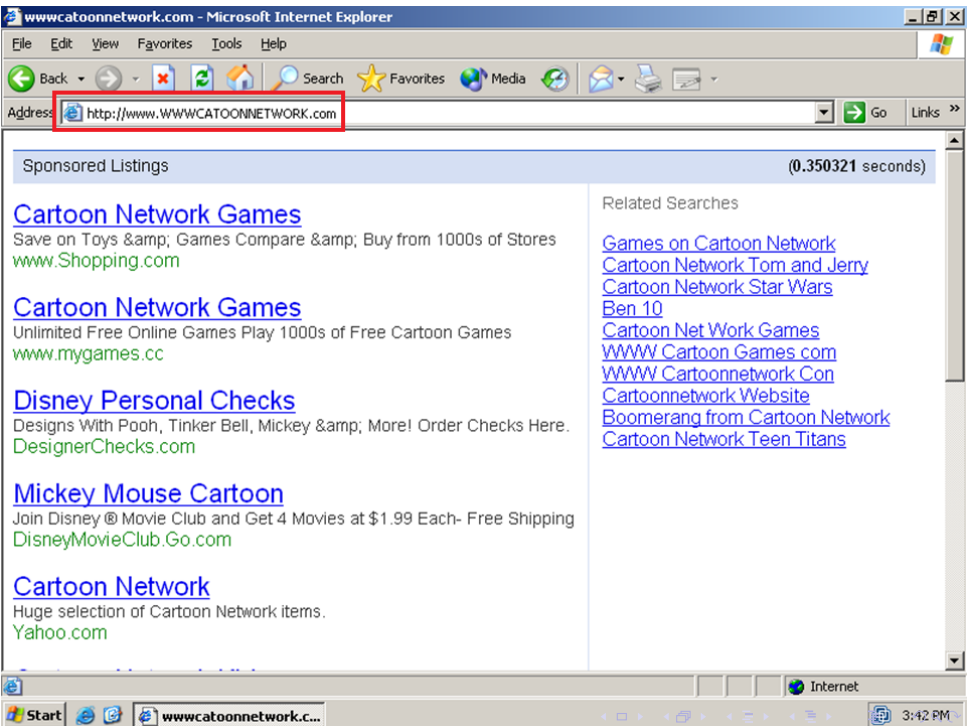
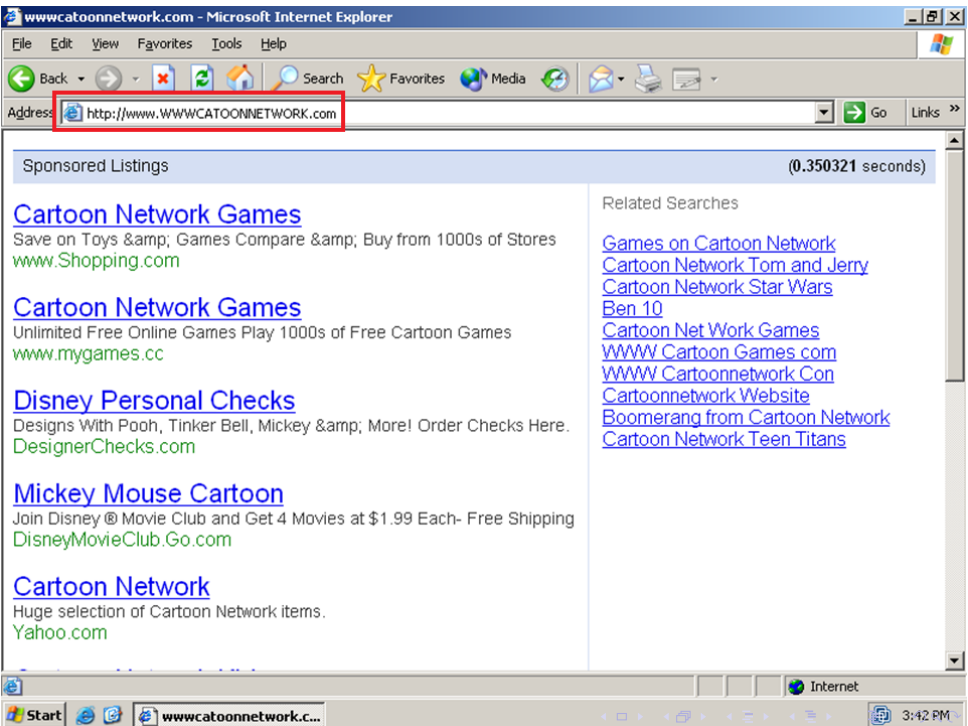


Measuring the Perpetrators and Funders of Typosquatting

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Harvard Business School

Financial Crypto, Tenerife, January 27, 2010
<http://www.benedelman.org/typosquatting/>



Outline

- 1 Measuring Typosquatting
 - Motivation and Industry Structure
 - Identifying Typosquatting Domains
 - Crawling Typosquatting Websites
- 2 How Typosquatting Domains are Used
 - Squatter Strategy 1: Pay-Per-Click Ads
 - Squatter Strategy 2: Redirection and Linked Domains
 - Do Pay-Per-Click Ads Promote Typosquatting?
- 3 Countering Typosquatting
 - Existing Efforts to Regulate Typosquatting
 - Identifying Servers that Distinctively Host Typo Domains
 - The Role and Responsibility of Ad Platforms

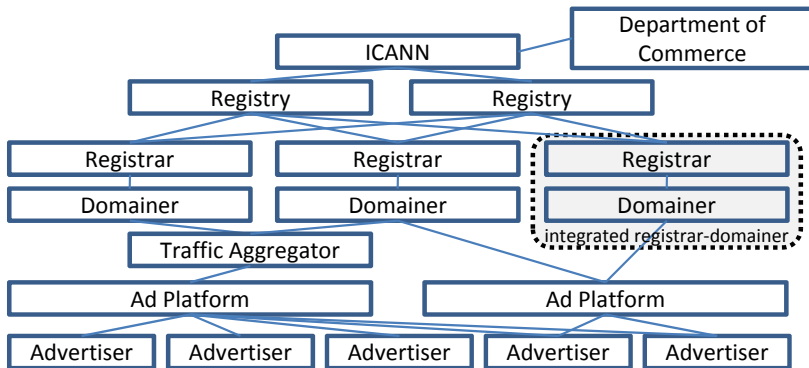
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Why care about typosquatting?

- Typosquatting confuses consumers, harms user experience
- Illegal under Anti-Cybersquatting Consumer Protection Act (1998)
 - Forbidden to register, traffic in or use domains confusingly similar to trademarks
- Undermines efficiency of online advertising market
 - Companies pay for traffic already intended for destination
 - Forces defensive advertising
- Squatters employ high-volume, low-success, automated approach similar to spam, phishing and other online crime

Structure and strategy of the domaining business



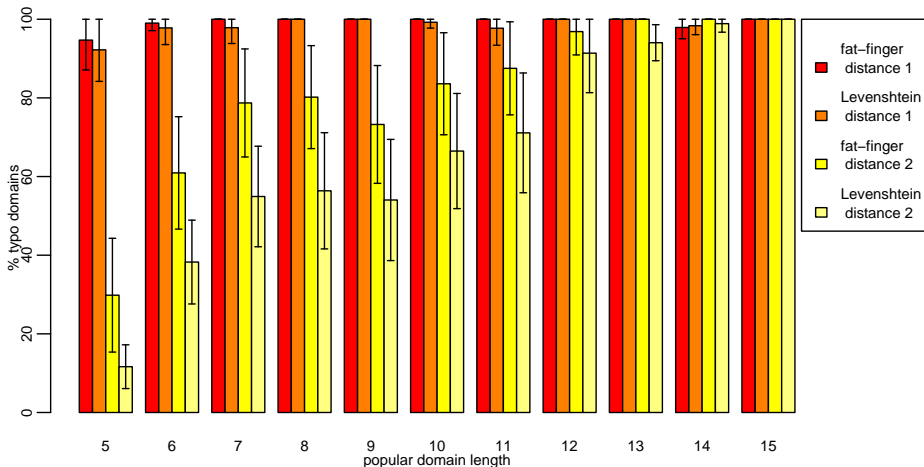
How to find typosquatting domains

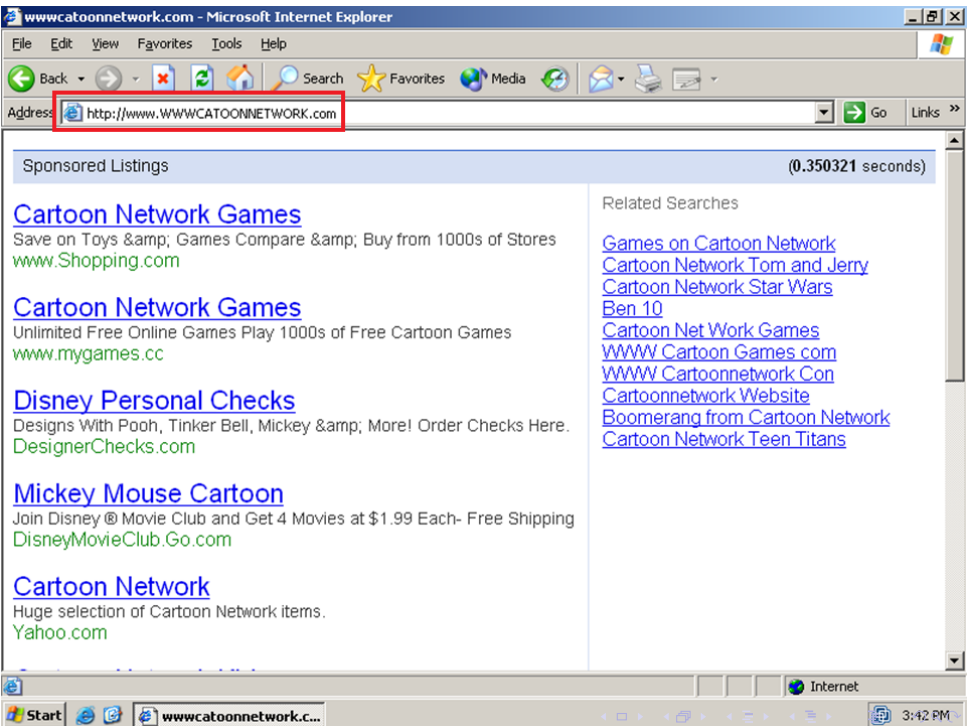
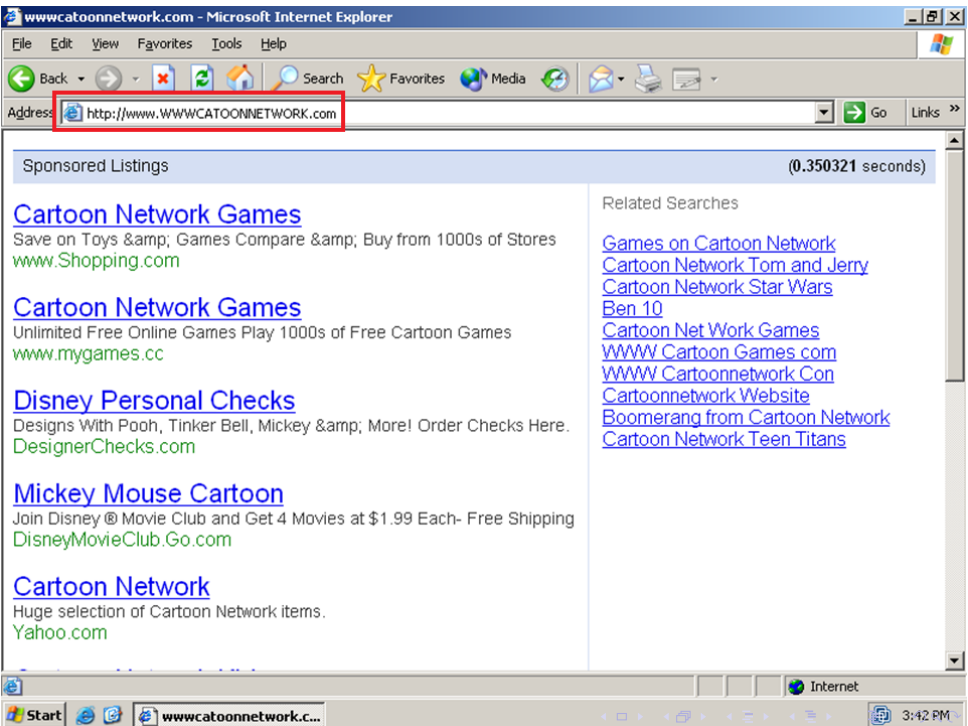
- Gather a list of *popular domains*
 - 3 264 .com domains \geq 5 characters long in Alexa top 6 000
- Compute Damerau-Levenshtein distance between popular domains and **all** registered .com's
 - Minimum # of insertions, deletions, substitutions or transpositions needed to transform one string into another
 - facebookk, facebok, faceboik, and faceboko each have a Damerau-Levenshtein distance of 1 from facebook
- Also compute **fat-finger distance**
 - Minimum # of insertions, deletions, substitutions or transpositions *using letters adjacent on a QWERTY keyboard* to transform one string into another

How to find typosquatting domains

- ① Enumerate all strings with a Damerau-Levenshtein (& fat-finger) distance ≤ 2 from each of the 3 264 popular domains
- ② Intersect this set with 81 million active .com domains
 - 1 910 738 candidate typo domains match 3 264 popular domains
- Manually sampled 2 195 randomly selected candidate typos
 - 50 domains each for Lev. and fat-finger distance 1&2, for popular domains of length 5–15

Typosquatting classification accuracy







Related Searches: [Www cartoon network games com](#) | [Cartoon networks](#) | [Cartoonnetwork](#) | [The cartoon network](#) | [Cartoon network play games](#) | [Cartoon network play](#) | [Cartoon network home](#) | [Cartoon network games com](#) | [Cartoon Network TV](#) | [Cartoon Network](#) |

CARTOONNETWOIRK.COM

Language: English

Sponsored listings

[Cartoon Network Games](#)

Save on Toys & Games Compare & Buy from 1000s of Stores

[www.Shopping.com](#)

[Disney Cartoon](#)

Join Disney® Movie Club and Get 4 Movies at \$1.99 Each- Free Shipping

[DisneyMovieClub.Go.com](#)

[Cartoon Network Games](#)

Unlimited Free Online Games Play 1000s of Free Cartoon Games

[www.mygames.cc](#)

RELATED SEARCHES

- [Www cartoon network games com](#)
- [Cartoon networks](#)
- [Cartoonnetwork](#)
- [The cartoon network](#)
- [Cartoon network play games](#)
- [Cartoon network play](#)
- [Cartoon network home](#)
- [Cartoon network games com](#)
- [Cartoon Network TV](#)
- [Cartoon Network](#)

1 278 cartoonnetwork.com typos, including...

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cartoonnetsork.com	cartoinnetwork.com	cartolnnetwork.com	cartoonnftwork.com	cartoonneywork.com
cartoonntewrk.com	cartoonnetlor.com	cartoonnetowok.com	crtonnetwork.com	cartoonnegwork.com
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cartomnetwork.com	cartoonnetwrak.com	cartoonnetorg.com	cratonnetwork.com	crtoonnetwork.com

How the crawler works

- Built a crawler to determine how typosquatting domains are used
 - 937 918 sites too many to crawl, and contains too many false positives
 - So instead visit 284 914 domains where the Damerau-Levenshtein distance is 1 for popular domains 5–9 characters long, or the Damerau-Levenshtein distance ≤ 2 for popular domains ≥ 10 characters
- For each domain, pull down index page and headers, and visit 3 randomly selected links up to depth 3
- Stop when a link or redirect to known advertising domain is encountered

What the crawler found

- Successfully classified 93 251 domains
 - 74 024 have pay-per-click ads
 - 19 227 use redirection or links to popular domains or competitors
- Blocked by 124 211 domains
 - CAPTCHAs, connection refused, etc.
 - Main reason for blocking: many domains are hosted on a few servers (up to 30K typo domains hosted on a single IP address)
- Unclassified 70 729 domains
 - Incorrect or incomplete javascript parsing, etc.

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Pay-per-click ad breakdown

ad platform	typo domains	%
Google	53 364	59.3
Yahoo!/Overture	19 145	21.3
Ask.com	555	0.6
Miva	541	0.6
Enhance	297	0.3



wal-marat.com

Below are sponsored listings for goods and services related to: wal-marat.com

Sponsored Listings

[Walmart Stores](#)

Find Products at Great Prices.

[www.Pronto.com](#)

[Always Low Prices...](#)

Shop online for exclusive savings on electronics, jewelry and more.

[www.Walmart.com](#)

[Walmart Employment](#)

Apply right away. Start today. No Experience Necessary. F/T or P/T

[Paid-Work-at-Home.com](#)

[Retailer EDI Solutions](#)

Simple and Integrated EDI solutions Inexpensive. Easy. Great support!

[www.xebecdata.com](#)

[Wall Mart](#)

Shopping Made Easy at Yahoo! Low Prices On Wall Mart.

[shopping.yahoo.com](#)

[Find Jobs in Your Area](#)

Jobs listings from thousands of websites in one simple search.

[indeed.com/Jobs](#)

[Wal-Mart Survey \\$1000](#)

Take the survey to provide valuable information.

[www.surveyhelp.org](#)

Related Searches

[WWW Walmart](#)

[Walmart Store Locator](#)

[Discount Department](#)

[Stores](#)

[Walmart Locations](#)

[Walmart Canada](#)

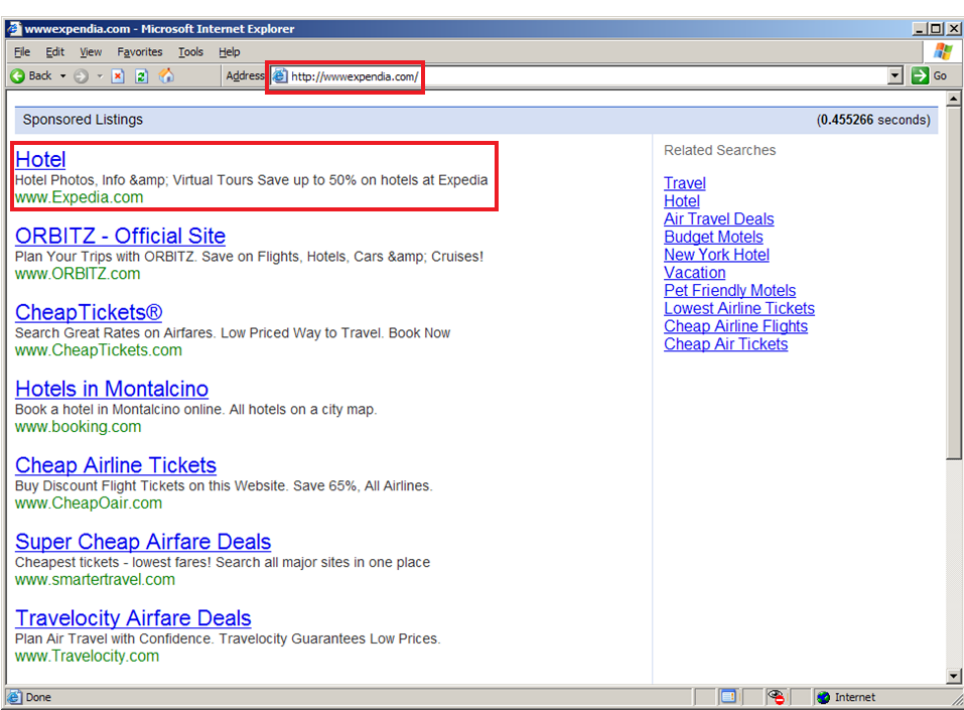
[Walmart Super](#)

[Walmart SuperCenter](#)

[Walmart CA](#)

[Walmart Superstore](#)

[Walmart Toys](#)



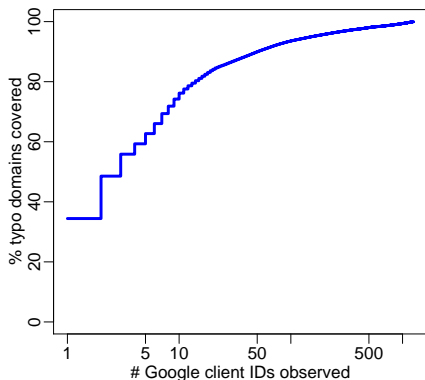
Self-advertisement prevalence for 263 popular domains buying ads

self-advertising rate	popular domains	examples
$\geq 75\%$	18	papajohns (90%), saksfifthavenue (88%)
$50\% \leq \dots < 75\%$	58	expedia (50%), t-mobile (70%)
$25\% \leq \dots < 50\%$	106	wellsfargo (43%), businessweek (48%)
$< 25\%$	81	findlaw (21%), tigerdirect (22%)
overall: 36%	263	

Inferring advertising partners from advertising links

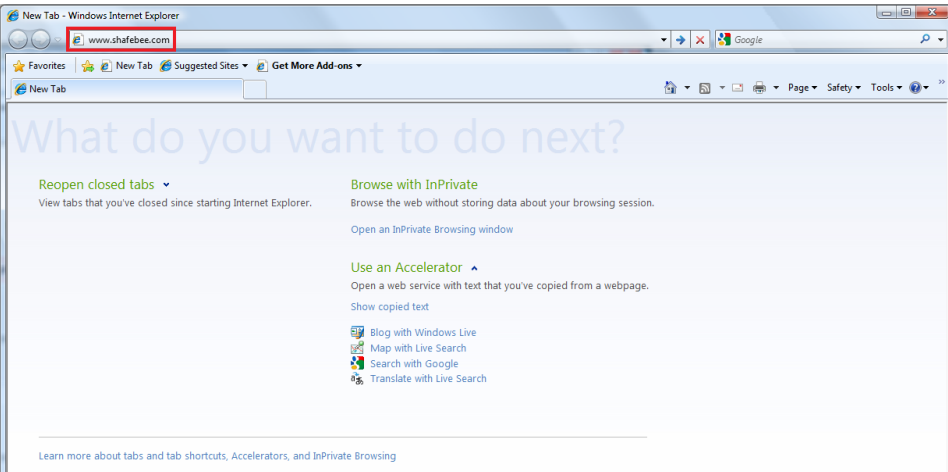
- Can often infer the advertising partner from a parameter included in advertising link
 - Yahoo ads obfuscate URL parameters, but Google does not
- `http://domains.google syndication.com/apps/domainpark/results.cgi?client=ca-dp-mborin&...`

Few advertising client IDs match most typo domains

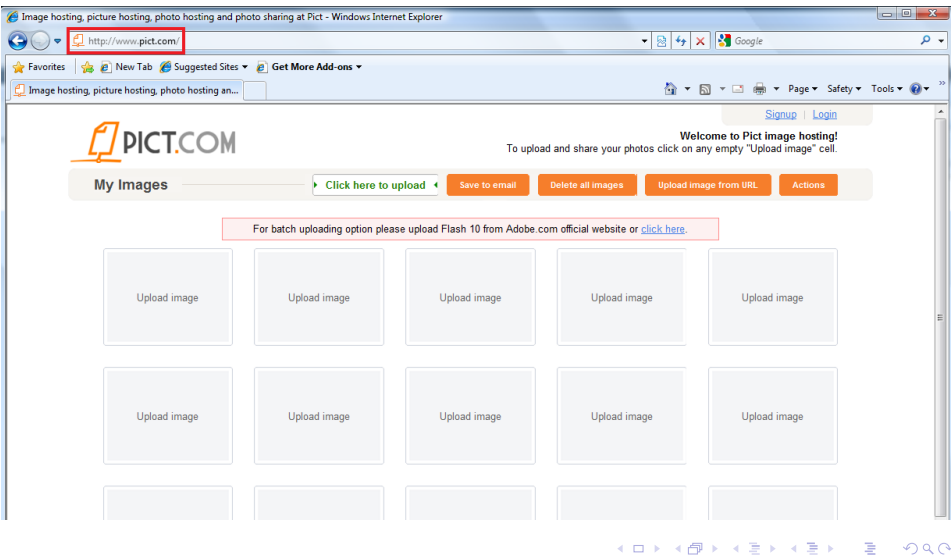


Google client ID	values	domains
ca-dp-highlands*	7	14 724
ca-dp-godaddy*	37	7 949
ca-dp-sedo*	14	4 583
ca-dp-sphere*	7	3 809
ca-dp-dopa*	5	1 402
ca-dp-namedrive*	12	489
ca-afdo-pub*	447	1 299
others	721	4 969
total	1 250	39 238

A user mistypes sharebee.com (Alexa rank 1 673)



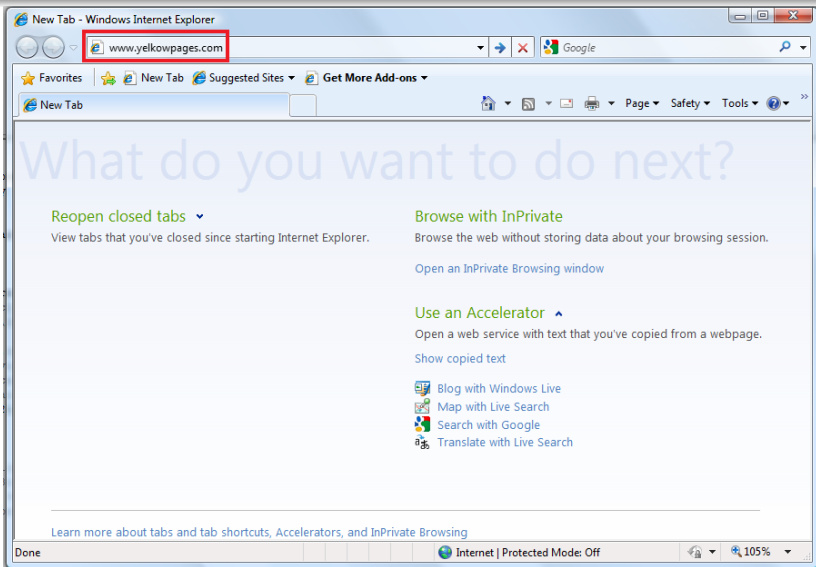
...and is redirected to pict.com (Alexa rank 8581)



128 typo domains redirecting to pict.com

depositfiles.com typos:	deposktfiles.com depositciles.com depowitfiles.com depositfkles.com depositfilee.com	depositfimes.com depositfkles.com depositciles.com depositfipes.com cepositfiles.com	depositfipes.com deposigfiles.com deposktfiles.com deposigfiles.com deposutfiles.com	deposutfiles.com deplsitfiles.com depositfimes.com deposutfiles.com depowitfiles.com	depoeitfiles.com depositfilee.com depoeitfiles.com deplsitfiles.com
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webshots.com typos:	webshlts.com	webshots.com	webshlts.com	webshots.com	
4shared.com typos:	4shafed.com	4shaged.com	4shaged.com	4shafed.com	

A user mistypes yellowpages.com (Alexa rank 762)



...redirected to yellowpagesoftheworld.com (rank 884 116)

Yellow Pages of the World.com - Portal for Yellow Pages and Yellow Pages Ads - Windows Internet Explorer

http://www.yellowpagesoftheworld.com/

Yellow Pages of the World.com - Portal for Yellow Pages and Yellow Pages Ads

white pages

Phonebook of the World

Yellow Pages

Select country:
Phonebook of America.com (+1)

White Pages of the World.com

Yellowpages in Europe

Local Yellow Pages USA

Phonebook of Albuquerque.com
Phonebook of Anchorage.com
Phonebook of Austin.com
Phonebook of Boston.com
Phonebook of Buffalo.com
Phonebook of Chicago.com
Phonebook of Columbus.com
Phonebook of Dallas.com
Phonebook of Denver.com
Phonebook of Detroit.com
Phonebook of El Paso.com
Phonebook of Fort Worth.com
Phonebook of Honolulu.com
Phonebook of Houston.com
Phonebook of Indianapolis.com
Phonebook of Jacksonville.com
Phonebook of Kansas City.com
Phonebook of Las Vegas.com
Phonebook of Los Angeles.com

Hotels

Yellow Pages

If you need Yellowpages in America simply go to
Phonebook of America.com

Find a Business

Business Type or Name

City or ZIP/Postal Code

State

'All States'

Yellow Search

5th Avenue visit

Ads by Google

YellowPages.com
Search AT&T
YellowPages For Local
Businesses, Services &
Information!
www.YellowPages.com

White Pages - Search Free
Current Phone,
Address, Age & More.
Search by Name-Cell
Phone-SSN-More.
www.PeopleLookup.com

Yellow Pages
Search For Local
Businesses, People and

156 domains redirecting to yellowpagesoftheworld.com

yellopasges.com	yeollwpages.com	ydlowpages.com	yellowpanes.com	yelkowpages.com
yellowpagyes.com	yellowpaegs.com	yerllowpages.com	yepllowpages.com	yellowzpages.com
yellowpoages.com	yellowpes.com	yellowwages.com	yellowqpages.com	yellowpasges.com
wwwyellowpags.com	wwwellowpages.com	yellowpazges.com	yellowpagfes.com	yellowpagex.com
yellowpagee.com	yellowpagea.com	yellowawpages.com	yellowespages.com	yellowpagezs.com
jellowpages.com	wwwyellowpages.com	ytellowpages.com	yelliwpages.com	yellowpajes.com
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vellowpage.com	yellowpsages.com	yvllowpage.com	yelloewpages.com	vekkowpages.com

Automatically identifying typos that link to competitors

- Explore the **beneficiary domains** linked to by typo domains
- Websites such as `pict.com` are picky when it comes to registering typos
- So the heuristic has two conditions
 - 1 Beneficiary domains must be linked by **at least** 75 typo domains
 - 2 Typo domains must impersonate **at most** 40 popular domains

Other example domains linked to by popular domains

bet365.com: **367 typo domains**

sportsbook.com: saportsbook, sxportsbook, sportszbook & 325 more

betclic.com: betclico, betclicm, betclicj & 7 more

fulltiltpoker.com: fulltilt6poker, fuylltiltpoker, fulltiltpoke4r & 5 more

smashinggames.com: **376 typo domains**

dailyfreegames.com: dailyfreegsmes, dwilyfreegames, dailygreegames & 35 more

freeworldgroup.com: freeworldhroup, freeworldgroup, freeeorldgroup & 33 more

modthesims2.com: modthrsims2, mpdthesims2, modrhesims2 & 27 more

movietheatertickets.biz: **85 typo domains**

movietickets.com: movietikits, mpvietickets, muvietickets & 19 more

rottentomatoes.com: rottentomaos, rottentmoatoes, rotentomatoe & 10 more

fandango.com: fansango, fandnango, faneango & 9 more

**total: 75 beneficiary domains on 4 879 typo domains impersonating
668 competing popular domains**

Other redirections and links from typo domains

- Companies also defensively register misspellings
 - Found 4 133 typo domains redirect to corresponding popular domain **and** use same name server as popular domain
- Affiliate marketing
 - Another way to monetize traffic intended for popular domain
 - Squatter receives commission from popular domain for providing a 'lead'
 - Suspect affiliate marketing is used in 10 185 domains

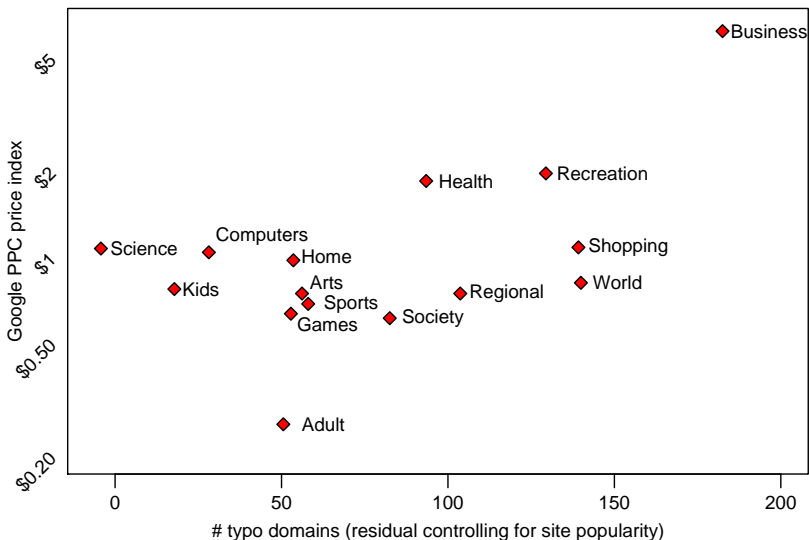
Why are some domains typosquatted more than others?

- Hypothesized that hard-to-spell sites are disproportionately targeted
 - Found no effect for various proxies of difficulty, including # of double letters, i/e or e/i presence
- Did find significant difference across website categories, as assigned by Alexa
 - Might pay-per-click ad prices help explain the difference?

Google PPC price index

- Extracted META keywords for every popular domain in each category
- Fetched the minimum and maximum PPC price estimates for each category's top 10 keywords using Google Traffic Estimator
- Define **Google PPC price index** as average of
 - 1 median of minimum PPC prices for keywords in the category
 - 2 median of maximum PPC prices for keywords in the category

Websites with higher PPC payouts face more typosquatting



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Existing efforts to regulate typosquatting

- ① Uniform Domain-Name Dispute-Resolution Policy (UDRP)
 - Reduced cost and sped up removal of infringing domains
 - Invoked 45 000 times between 1999-2009
- ② ACPA allows trademark holders to sue **in rem**
 - Can sue the domain itself, even if the registrant is nowhere to be found
 - Puts registrars and registries on the hook instead
- ③ ACPA also allows for statutory damages (\$1K–\$100K per domain)
 - Intent was to deter would-be typosquatter with threat of fines

Challenges to existing regulatory efforts

- A few lawsuits have been successful
 - Verizon (\$33 million judgment), Microsoft, Neiman Marcus
 - Yet even these marks are still typosquatted: Verizon (767), Microsoft (437), Neiman Marcus (65)
- 45 000 UDRP requests covers less than 5% of the typosquatting domains identified
- Conclusion: individual trademark holders, pursuing individual squatters, have not been effective in stopping typosquatting
- Should instead influence those who distinctly benefit from typosquatting: domain aggregators and ad platforms

Name servers with the most typosquatted domains

Name servers > 100 000 domains

name server	% typo	typos
dnsnameserver.org	4.75	19 217
trellian.com	4.47	11 962
hitfarm.com	3.76	17 073
dsredirection.com	3.60	59 845
linkz.com	2.98	3 765
fastpark.net	2.77	7 715
above.com	2.77	16 691
sedoparking.com	2.51	35 216
parked.com	2.48	13 993
trafficz.com	2.38	5 337
bottom 5	:	:
ipowerweb.net	0.32	569
ipowerdns.com	0.30	522
123-reg.co.uk	0.26	860
abac.com	0.14	248
vpweb.com	0.12	127

Name servers > 1 000 domains

name server	% typo	typos
moniker.com	61.65	910
ipmanagerinc.net	55.63	787
citizenhawk.net	31.88	1 766
dexner.com	18.85	375
aphost.com	17.96	4 244
freeredirection.net	17.94	1 438
ehostinginc.com	17.89	181
nnw.net	17.10	250
onlinednsservice.net	15.09	2 844
topdns.com	15.01	889
plus 96 name servers above 5% typo domains		

Role and responsibility of ad platforms

- 80% of crawled typo domains show pay-per-click ads from ad platforms operated by top search engines
- Ad platforms are well-placed to stop typosquatting
 - Select partners more carefully
 - Sever ties to partners found to engage in typosquatting
 - Deduct penalties from payments to partners found to be typosquatting
 - ...
- Ad platforms can prevent typosquatting with less effort than other parties
 - Already developed good typo detection for core business ('Did you mean?')
 - Feasible to stop syndicating ads on misspellings of top trademarks, thereby eliminating the squatters' main revenue source

Conclusion

- Typosquatting remains widespread – nearly 1 million domains impersonating top 3264 .com sites – despite more than a decade of public and private efforts
- The financial payout from advertisers and ad networks outweighs any individual efforts from trademark holders
- High concentration at a few large domainers and ad platforms means intermediaries could reduce typosquatting if so inclined
- See online appendix for more examples
<http://www.benedelman.org/typosquatting/>
- For more ...
 - Web: <http://people.seas.harvard.edu/~tmoore/>
 - Email: tmoore@seas.harvard.edu