RESEARCH

An Investigation of the Performance of UK ISP Web Filters

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Abstract

To do

Keywords: sample; article; author

Introduction

Context/Problem -Introduction of UK ISP Web Filters -Questions over: –the need for this (cite ofcom survey states) –their accuracy, given that the ISPs use third-party systems or categorisations –how they can be held to account –who is responsible for their oversight (this is left vague)

Motivation: -If we can study and therefore understand how web filters function, then we can also gauge their accuracy and in turn perceive how effective they are. We can also understand what the by-products are of this censorship

Research Questions: -Can we understand how UK ISP Web Filters function, and how accurate they are? -Are they reliable at blocking content, in terms of both overblocking and underblocking? And are there certain categories of web sites that are error prone? -How long does it take an ISP to fix an error?

This paper presents the first systematic study of UK ISPs' web filters, how they function, their accuracy, and their failings. We take a data science perspective and use data extracted from ISP filter probes

We adopt a macro-to-macro analysis of the data to first examine

Related Work

-Explain existing studies of web censorship –Explain how the UK approach is different as it is via UK ISPs and therefore pushed out to the private sector

Studied Internet Service Providers

-Explain which internet service providers are included –Different blocking settings used and analysed (e.g. BT moderate, BT strict, etc.) -Explain what —SPs use which companies services

Analysed Internet Service Providers

Broadband Providers

-BT -Plusnet -Sky -TalkTalk -VirginMedia

Mobile Providers

-EE -O2 -T-Mobile -VirginMobile -Vodafone

Blocking Approaches

-BT: –provides a system known as 'BT-parent controls'[1] which uses DNS-based blocking of URLs –uses site categorisation information from Nominum –Provides three levels of filtering once controls are turned on: (i) light, which blocks pornography, obscene and tasteless, hate and self-harm, drugs, alcohol and tobacco, and dating; (ii) moderate, which blocks all of the light filter setting's content and nudity, weapons and violence, gambling, and social networking, and finally; (iii) strict, which blocks all of the above plus fashion and beauty, file-sharing, games, and media streaming.

-Plusnet –provides a system known as 'Plusnet Protect'

-Sky –provides a system known as 'Sky Broadband Shield' which also uses DNS-based blocking of URLs –uses site categorisation information provided Symantec and their Rulespace Web Content categorisation system[2] –Also offers three levels of categorisation: (i) 18 which blocks malware sites; (ii) 13 which blocks cyberbullying, pornography, suicide and self-harm, drugs, dating, and malware sites, and; (iii) PG which blocks all of the above plus social networking and online gaming.

-Talk Talk –Talk Talk Homesafe –Uses DPI to examine URLs being visited by users. Sites blocked using DNS-spoofing –Includes setting of 'Kids-Safe' filter that allows certain categories of sites to be blocked: "Dating", "Drugs, Alcohol and Tobacco", "File Sharing Sites", "Gambling", "Games", "Pornography", "Social Networking", "Suicide and Self-Harm", "Weapons and Violence".

-VirginMedia: provides a system known as 'Web Safe'[3] which is a DNS-based system that matches requested URLs with known blocked URLs in a DNS-lookup table. –uses site categorisation information from Nominum –Data was not immediately available of what VirginMedia blocks, therefore used the OFCOM Internet Safety Measures report.

Good overview of which categories the filters cover is included in the OFCOM Internet Safety Measures report from 2014.[4]

[1] http://www.productsandservices.bt.com/products/manage-broadband-extras/

[2] http://www.symantec.com/page.jsp?id=rulespace

[3] http://my.virginmedia.com/my-apps/websafe.html

[4] http://stakeholders.ofcom.org.uk/binaries/internet/internet_safety_measures_2.pdf

Monitoring Web Filters

-Explain the framework that was used for this -Explain the submission interface and the use of the blocked portal to check what has been blocked and unblocked -Gathering evidence of overblocking and underblocking -Show the distribution of requests per day per ISP filter

Figure 1 Number of URL requests made over time since the beginning of the project.

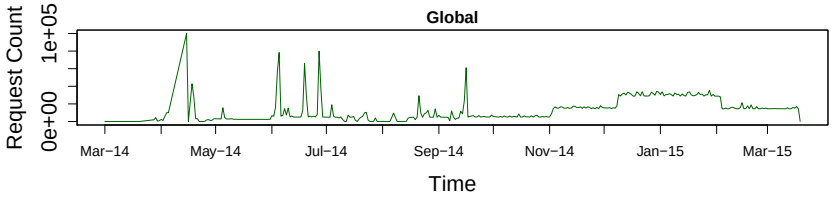


Figure 2 Number of URL requests made per broadband ISP filter

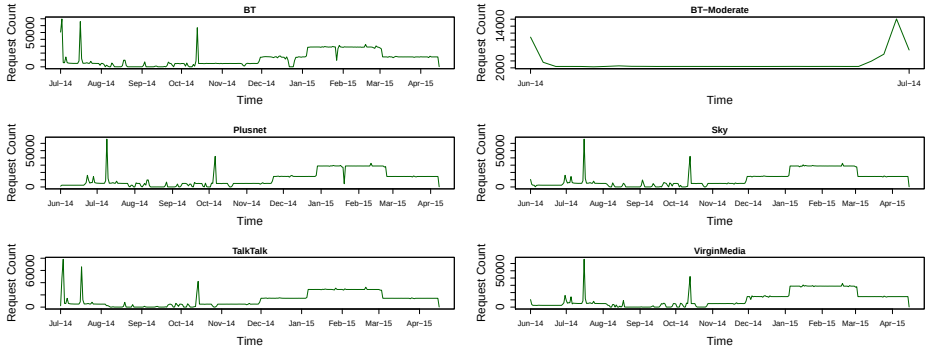
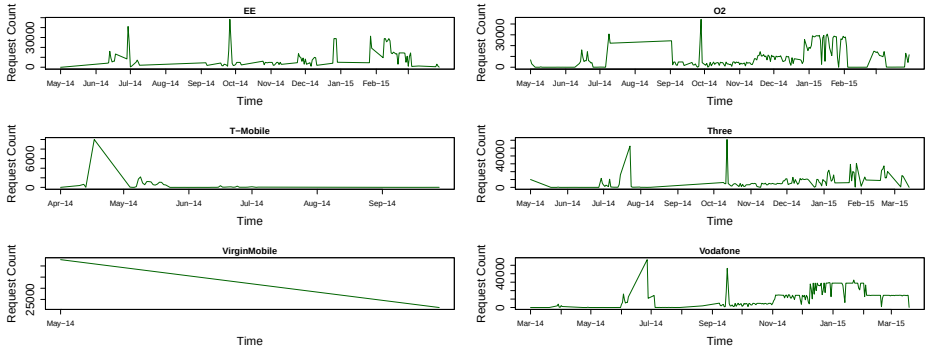


Figure 3 Number of URL requests made per mobile ISP filter



Mobile ISP findings: -Dropping VirginMobile from the analysis as there was a problem with the data -Can only analyse T-Mobile up to the end of September 2014

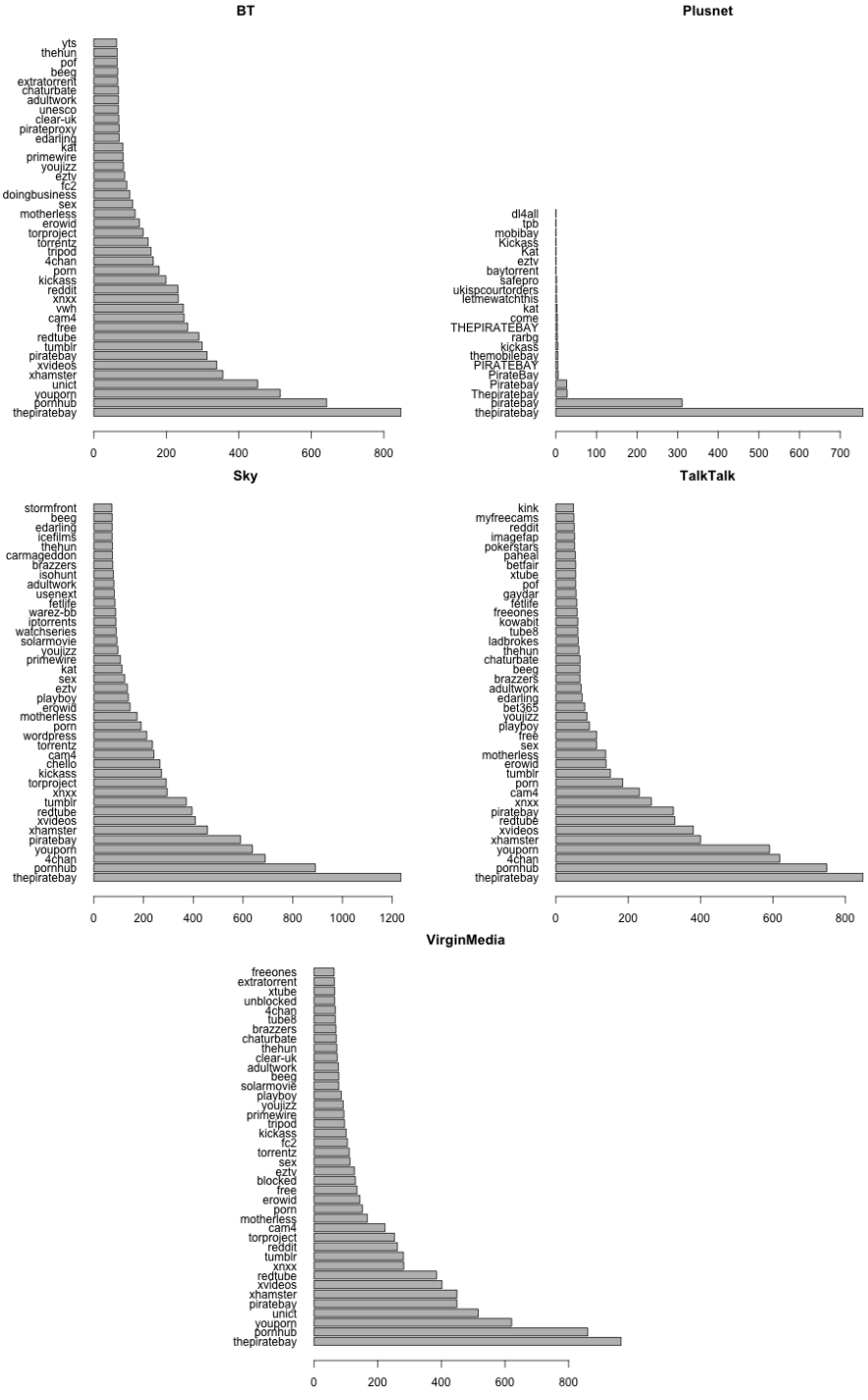
Dropped filters: -BT-Moderate -VirginMobile -T-Mobile

Blocked Content

Blocked Domains

-Report on distribution of domains that are blocked so far to date (ignoring changes)

Figure 4 Distributions of blocked domains for broadband ISPs This presents which domains each ISP has blocked and the frequency distribution of those domains.



To do: -Add analysis of wordpress, tumblr, reddit, and livejournal sites

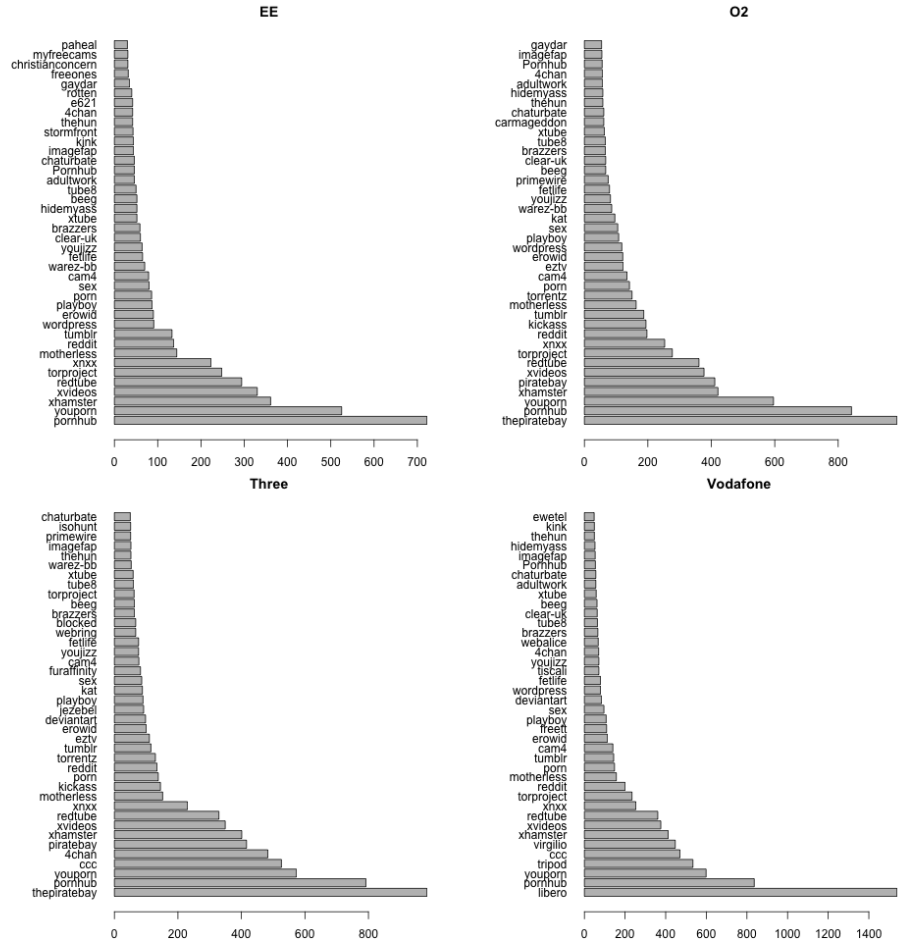


Figure 5 Distributions of blocked domains for mobile ISPs This presents which domains each ISP has blocked and the frequency distribution of those domains.

Wordpress Examples: -URL: http://beeractivist.wordpress.com — Submitted: 2014-11-30 21:13:51 — NetworkName: TalkTalk — Status: blocked -URL: http://tantracore.wordpress.com — Submitted: 2014-11-30 22:13:28 — NetworkName: Sky — Status: blocked -URL: http://garsai.wordpress.com — Submitted: 2014-11-30 23:02:46 — NetworkName: TalkTalk — Status: blocked -URL: http://toysoldier.wordpress.com — Submitted: 2014-07-03 15:03:15 — NetworkName: O2 — Status: blocked –This site is a support site for men who have been abused (also blocked by Sky) -URL: http://www.heyartist.wordpress.com — Submitted: 2014-11-30 20:56:34 — NetworkName: Sky — Status: blocked –Site promoting art as a support mechanism for enhancing wellbeing

Tumblr Examples: -URL: http://atlasofprejudice.tumblr.com — Submitted: 2014-05-14 01:12:57 — NetworkName: TalkTalk Strict — Status: blocked –Showing examples of maps that demonstrate the prejudices that countries have -URL: http://azurelunatic.tumblr.com/post/18654147576/ive-been-forced-to-explain-homosexuality-to-my — Submitted: 2014-05-27 21:27:00 — NetworkName: Vodafone — Status: blocked –Example of blocking a site as it contains an explanation of why some-

one is gay (potential prejudice here). Also blocked by O2, TalkTalk, and BT -URL: http://thusly.tumblr.com — Submitted: 2014-07-02 13:08:44 — NetworkName: EE — Status: blocked –Also blocked by BT, Sky, O2, Vodafone -URL: http://tldrwikipedia.tumblr.com — Submitted: 2014-05-14 01:13:11 — NetworkName: TalkTalk — Status: blocked -URL: http://notalkingplz.tumblr.com — Submitted: 2014-07-02 14:22:20 — NetworkName: O2 — Status: blocked –Also blocked on: Sky, Vodafone, EE

Reddit Examples: -Largely blocking http://www.reddit.com/r/nsfw, http://www.reddit.com/r/nsfl, and http://reddit.com/r/porn, all of which are sub-reddits containing adult content -URL: http://www.reddit.cm — Submitted: 2014-07-02 10:40:30 — NetworkName: Sky — Status: blocked -URL: http://reddit.com/r/creepypms — Submitted: 2014-07-05 20:10:31 — NetworkName: EE — Status: blocked –Subreddit sharing creepy private messages that people have received. Not necessarily adult content, and definitely not pornography.

Livejournal: -All appear to the sites of Russian sites (e.g. http://limonov-eduard.livejournal.com/)

-URL: http://community.livejournal.com/asi/ — Submitted: 2014-11-30 21:11:19 — NetworkName: Sky — Status: blocked –Anorexia and self-harm support community site. Contains posts from people explaining their afflictions and getting support from other people.

-URL: http://beer-retard.livejournal.com — Submitted: 2014-11-30 21:13:51 — NetworkName: TalkTalk — Status: blocked –Blocked due to discussing/containing information about alcohol/beer?

-URL: http://urban-decay.livejournal.com — Submitted: 2014-11-30 21:14:59 — NetworkName: Sky — Status: blocked –Also blocked by Three and O2

-URL: http://ercasse-ainince.livejournal.com/30230.html — Submitted: 2014-11-30 20:51:44 — NetworkName: Sky — Status: blocked –Article about films that have been out for a long time

-Largely blocking pornography live journal pages too

Blocked Site Categories

-Report on the distribution of categories of sites that are blocked –Explain the categorisation system used, and the various levels of categories –What is the coverage of URLs in the DMOZ categorisation system? Report on the % covered in the system

Given the DMOZ categorisation system and the use of ODP categories, we can use the hierarchy of the category taxonomy to only focus up to a specific depth; thereby restricting the categories to only depth of d.

-Not showing Plusnet as it blocks file-sharing category sites

Figure 6 Distributions of blocked level-4 categories for broadband ISPs.

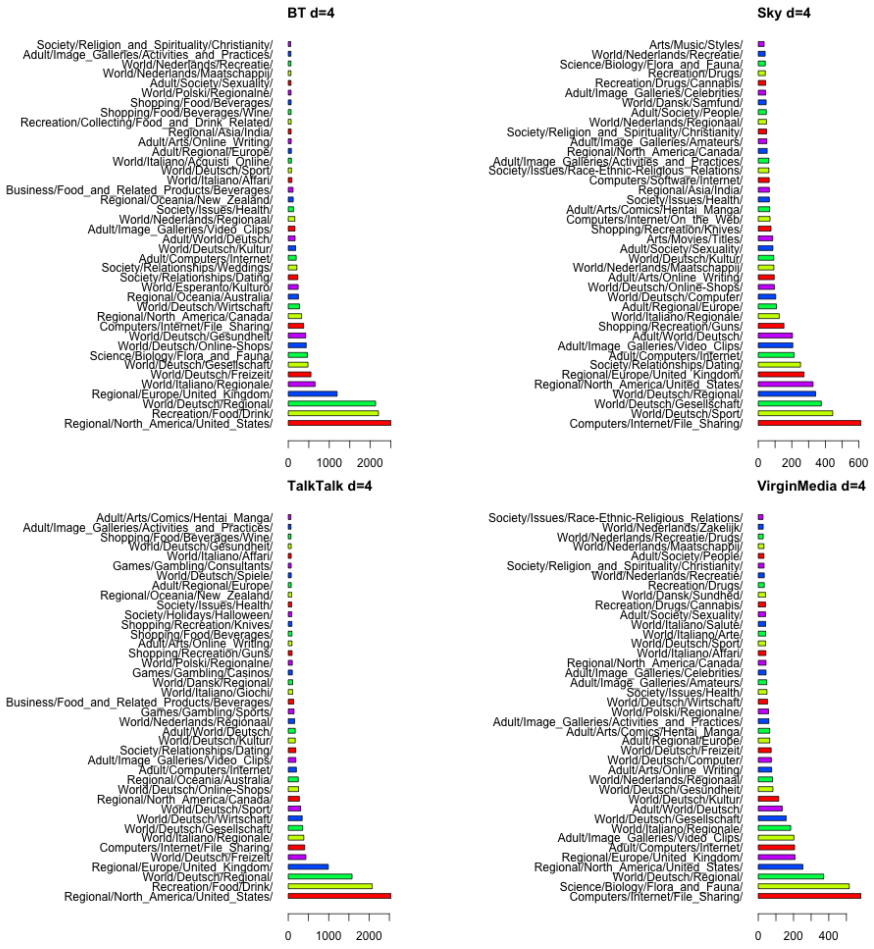
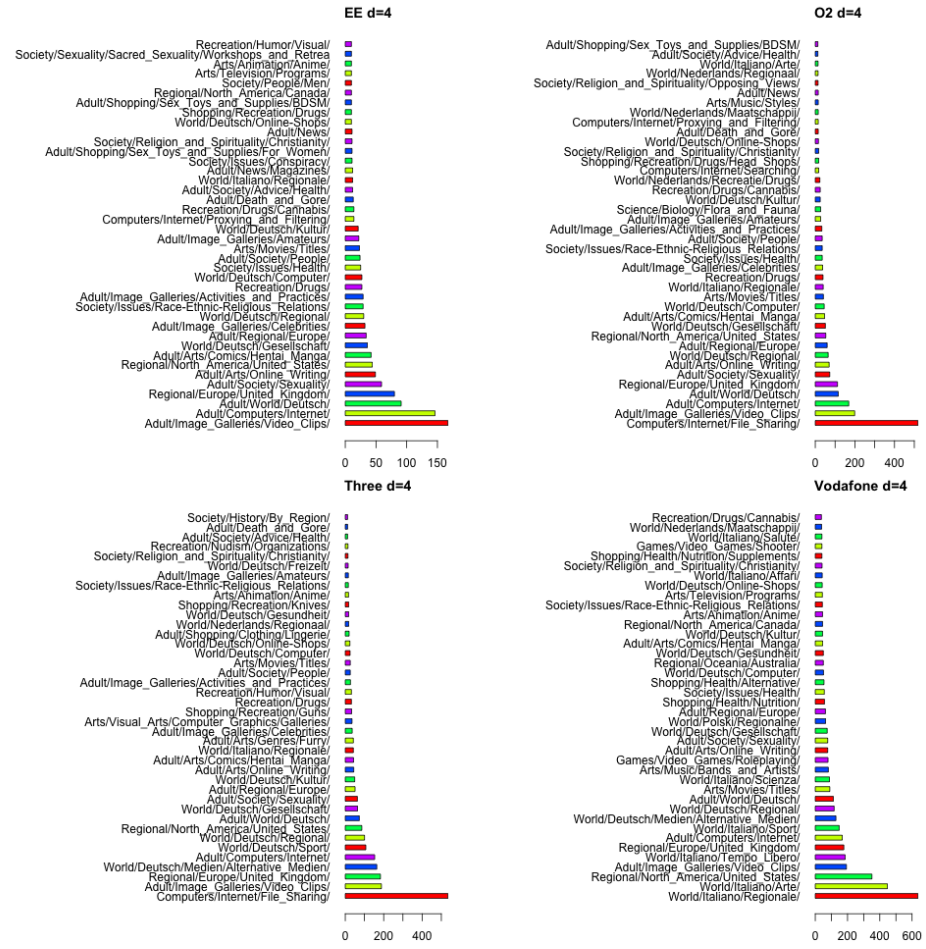


Figure 7 Distributions of blocked level-4 categories for mobile ISPs.



Gauging Filter Accuracy

-Report on reverse engineering the accuracy of the filters –Need to consider how to collect certain porrnographic examples here and push them to the blocked.org.uk queue –Report on the class balance between blocked vs not-blocked content –Can only consider URLs within the system? –Do the findings suggest a certain problem with the mechanisms used to classify urls?

Pseudo-Classifiers for ISP Filters

-Induce a pseudo-classifier for each ISP filter setting: –Specify which categories of content should be blocked by certain filter –Add table to explain this –Coded blocked topics into DMOZ categories to identify what the pseudo classifier should block. –Our approach is to always go as conservative as possible: i.e. if unsure about whether a category should be blocked, then block it. –Remove file-sharing for now, as this is assessed on a case-by-case basis and with court orders —I.e. blocking all of Computers: Software: Internet: File Sharing would lead to studies on file-sharing being blocked –Hence: block everything under Adult –Also block everything under Computers/Hacking

-BT: should block... –pornography (Adult/Image Galleries + Adult/Video Clips) –obscene and tasteless (Adult/Death and Gore) –hate and self-harm (no DMOZ category) –drugs (Recreation/Drugs) –alcohol (Recreation/Food/Drink/Drinking + Health/Specific Substances/Alcoholic Beverages) –tobacco (Shopping/Tobacco + Recreation/Tobacco) –dating (Society/Relationships/Dating, Society/Relationships/Cyber_Relationships)

-Sky: should block... –malware sites (Computers/Security/Malicious_Software/Spyware_and_Adware) –cyber-bullying (no cat on this, generally there are advice pages though) –pornography (Adult) –suicide and self-harm (no cat) –drugs (Recreation/Drugs) –dating (Society/Relationships/Dating) –social networking (Computers/Internet/On_the_Web/Online_Communities Kids_and_Teens/People_and_Society/Online Communities) –online gaming (Games/Online)

-TalkTalk: should block... –dating (Society/Relationships/Dating) –drugs (Recreation/Drugs) –alcohol (Recreation/Food/Drink/Drinking + Health/Specific Substances/Alcoholic Beverages) –tobacco (Shopping/Tobacco + Recreation/Tobacco) –File Sharing Sites (Computers/Software/Internet/Clients/File Sharing) –Gambling (Gamling) –online gaming (Games) –Pornography (Adult) –social networking (Computers/Internet/On_the_Web/Online_Communities/Social_Networking, Kids_and_Teens/People_and_Society/ Communities) –Suicide and Self-Harm (no cat) –Weapons and Violence (Adult)

VirginMedia: should block... –Crime, Violence, and Hate: (Adult) –Drugs (Recreation/Drugs/Cannabis + Recreation/Drugs/Psychedelics) –File Sharing Sites (Computers/Software/Internet/Clients/File Sharing) –Pornography (Adult) –Suicide and Self-harm (no category for this in DMOZ)

-EE, O2, and Three: should block...

–18 works are for adults and can contain strong issues such as: very strong violence, frequent strong language (e.g. 'f***') and / or very strong language (e.g. 'c***'), strong portrayals of sexual activity, scenes of sexual violence, strong horror, strong blood and gore, real sex (in some circumstances), discriminatory language and behaviour

-Vodafone: should block... –Our content control prevents access to 18-rated content on Vodafone live! (mobile internet) and blocks access to 18-rated websites, un-moderated chat rooms and listed child abuse sites.

From the DMOZ web site: Generally the Adult category includes sites whose dominant theme is either: -To appeal to the prurient interest in sex without any serious literary, artistic, political, or scientific value -The depiction or description of nudity, including sexual or excretory activities or organs in a lascivious way -The depiction or description of sexually explicit conduct in a lascivious way (e.g. for entertainment purposes)

Judging Filter Accuracy

Explain gauging filter accuracy using existing measures from classification literature. -Parallelisation of the accuracy measurement -Explain the role of Spark in this to distribute the work load -Explain the location of the code and how to run this -Explain how we calculate accuracy based on which requests were blocked and which were not blocked - we have to do this as a URL can go from blocked to unblocked and vice-versa –Question: how often is a given URL periodically tested for a block?

General Accuracy

Table 1 Accuracy levels of ISP and Mobile Providers' Web Filters derived using the DMOZ categories that should have been blocked by each filter and the categories of URLs that were actually blocked.

	Precision	Recall	FPR	MCC	F1
BT	0.032	0.613	0.012	0.138	0.061
Sky	0.088	0.370	0.003	0.179	0.142
TalkTalk	0.078	0.073	0.009	0.066	0.075
VirginMedia	0.050	0.508	0.003	0.159	0.091
EE	0.189	0.635	0.002	0.346	0.291
O2	0.136	0.697	0.002	0.307	0.227
Three	0.108	0.631	0.004	0.260	0.185
Vodafone	0.044	0.564	0.004	0.156	0.081

Table 2 Accuracy levels after filtering out sites from the World category subtree.

	Precision	Recall	FPR	MCC	F1
BT	0.066	0.612	0.010	0.198	0.119
Sky	0.163	0.372	0.003	0.245	0.227
TalkTalk	0.145	0.072	0.008	0.091	0.097
VirginMedia	0.112	0.512	0.002	0.239	0.184
EE	0.281	0.637	0.002	0.422	0.390
O2	0.218	0.699	0.002	0.390	0.333
Three	0.184	0.633	0.004	0.340	0.285
Vodafone	0.083	0.568	0.003	0.216	0.144

Table 3 Accuracy levels after filtering out sites from the World category subtree and controlling for breweries and other alcohol related sites.

	Precision	Recall	FPR	MCC	F1
BT	0.335	0.726	0.007	0.490	0.459
Sky	0.163	0.372	0.003	0.245	0.227
TalkTalk	0.422	0.176	0.006	0.262	0.248
VirginMedia	0.112	0.512	0.002	0.239	0.184
EE	0.281	0.637	0.002	0.422	0.390
O2	0.218	0.699	0.002	0.390	0.333
Three	0.184	0.633	0.004	0.340	0.285
Vodafone	0.083	0.568	0.003	0.216	0.144

Qualitative Examples of Blocks: -BT Block: http://www.lgbtquitsmoking.com/ (site to help people stop smoking).

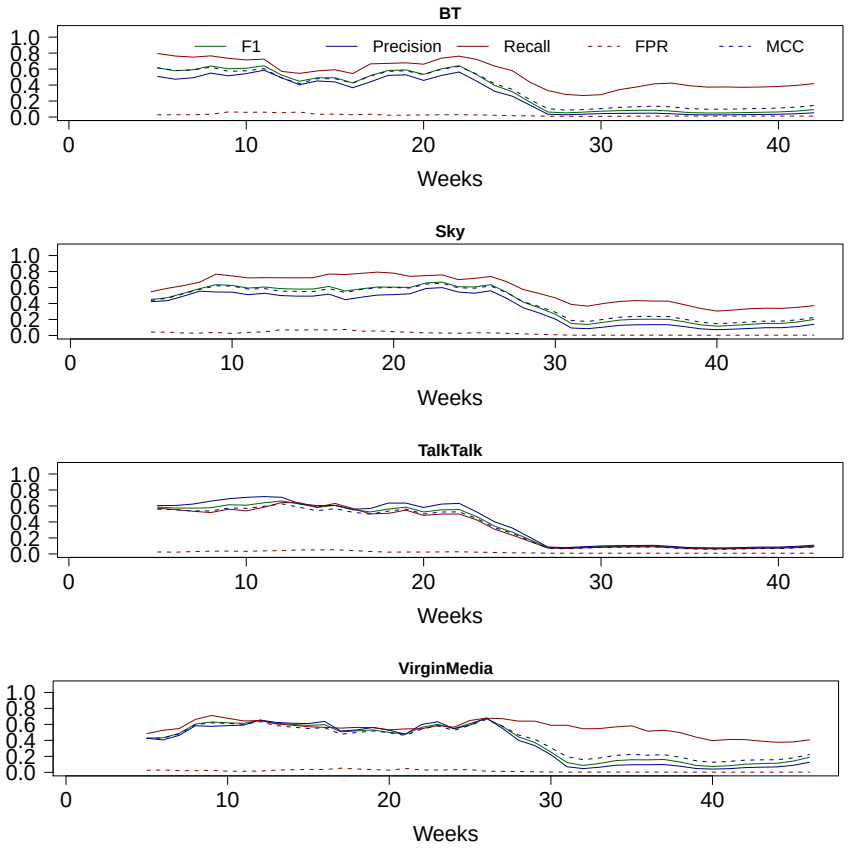
BT seem to be blocking tattoo web sites too:

We have uploaded the collection of sites which are false positives and false negatives to the github repo.[5]

Accuracy over Time

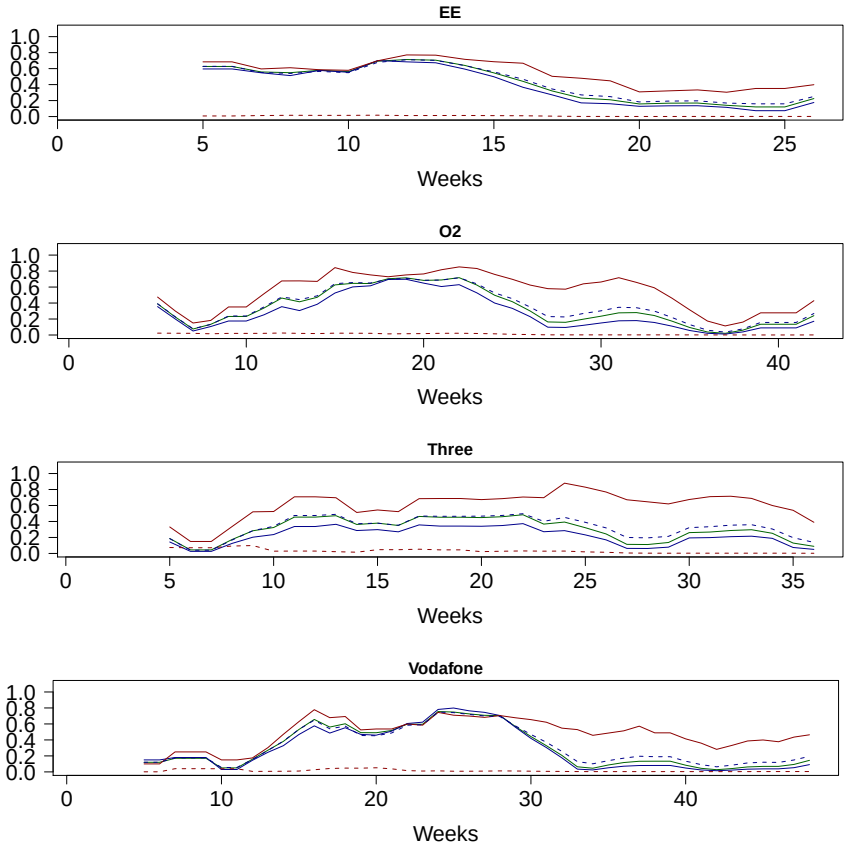
How has accuracy evolved over time? –Discrete time analysis of the accuracy levels - use weekly bins (Bayesian model?) Can we forecast accuracy?

Figure 8 Accuracy of Broadband ISPs' filters over time. ARIMA(0,0,5) plot of the accuracy measures: precision, recall, f-measure (F1), false positive rate (FPR), and the Matthews' Correlation Coefficient. Weeks are from the start of the ISP-specific filter logging period.



[5] https://github.com/openrightsgroup/cmp-analysis/tree/master/data/output

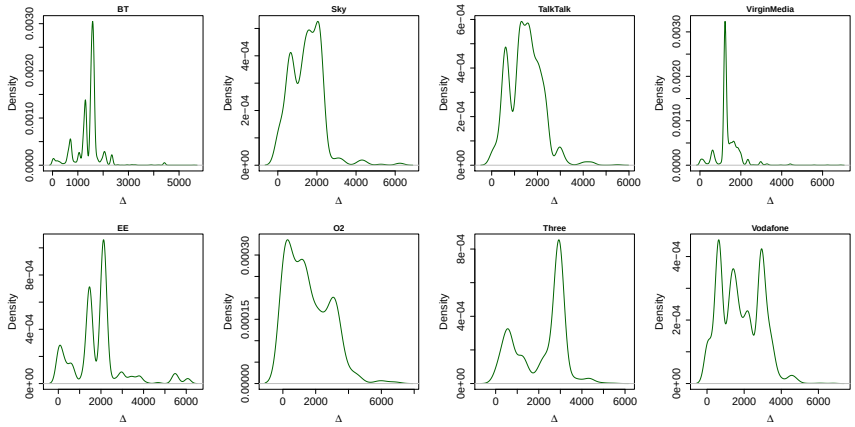
Figure 9 Accuracy of Mobile ISPs' filters over time. ARIMA(0,0,5) plot of the accuracy measures: precision, recall, f-measure (F1), false positive rate (FPR), and the Matthews' Correlation Coefficient. Weeks are from the start of the ISP-specific filter logging period.



Time to Correction

-Report on how long it takes each ISP to fix their blocked content -Show the delta distribution of each provider –Fit a distribution to the delta-function: Poisson?

Figure 10 Time to unblock (Δ) distribution of each Broadband and Mobile ISP in hours.



Study Limitations

Measurement of Blocks

-Defend the approach of analysing which requests were fulfilled - this can contain duplicate URLs (some of which were blocked, and some of which were not) –This can lead to repeated URLs in the lists of false/true positives and negatives –We counteract this by using sets to restrict each URL to one occurrence per set

-Explain possible limitations with the actual probe system itself.

Limitations of Pseudo-Classifiers

Limitations of this approach: -Relies on the classification of sites within DMOZ as being correct -Coverage of the DMOZ categories - as this is manually curated we only cover a % of the URLs in total that have been aligned with categories

-Use of DMOZ categories is not without errors: –E.g. the URL http://www.vin-gastronomie.com/ is not classed as should be blocked in the gold standard as its category is "World: Francais: Regional: Europe: France: Regions: Haute-Normandie: Eure: Commerce et economie: Gastronomie et alimentation', however the page describes wine brands

-Potential improvements: –Classifying content of the page to mine topics discussed therein - i.e. basic semantic analysis of the content –Filtering out categories of sites which may introduce noise into the results, and not counting them at all (e.g. those related to gastronomy).

Findings and Implications

Conclusions and Future Work

Competing interests
The authors declare that they have no competing interests.

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