

Classifying Adult Content Using Naive Bayes

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Why Care: "Raw" BM25

Search results 1-10 for **teens**

Total results: 2,590,000+ (retrieved in 1365.7ms)

Blacked Teen : young **teen** and **teen**, **teen** anal

www.watchmygf.com/search/blacked-teen.html ▾

take pleasure in Attainable and very sexy young **teen** is poked by her bf Fashionable and flirtatious young immature is having sex with her bf on a car Gaze this spicy immature being fornicated by her teacher of math cruelly Sexual and attainable young **teen** with wow jugs in her is doomed hard Long haired

Teen Pics – Teen Sex Teen Porn

teensexteenporn.com/category/teen-pics ▾

. * Hot Brunette **Teen** Girl Mikah Dildoing her Pussy with 3 Dildos at the Same Time Pictures * 18 Years Old Hot Nude Slim Body Blonde **Teen** Girlfriend Having Sex with her Boyfriend Sucking his Cock and Getting Pussy Fucked by Small Dick Hot Brunette **Teen** Girl Mikah Dildoing her Pussy with 3 Dildos at the

lesbian **teen** pics, lesbian **teen** pictures, lesbo **teens**, **teen** lesbians at

www.teens19.com/lesbian-teens.php ▾

Nude **Teens** features free sexy nude **teen** pictures and **teen** sex galleries, as well as nubile sex photos. And what about all these beautiful nude **teen** girls showing off their perfect body for you, with perky tits, puffy nipples and tight **teen** ass?

Teen Sex - naked teens, hot teens and sexy teens

to-teens.com/ ▾

We have a lot of free **teen** sex videos and young fuck clips full of hardcore sex, young lesbian sluts, hot anal fucking and many more.

Teen Pussy Teen Sex Teen PornPuss In Boots | Teen Pussy Teen Sex Teen Porn

www.teenpussysexporn.com/puss-in-boots ▾

Here we offer for you to see best **teen** pussy and also to see how that **teen** pussy makes some sex or acts in hardcore porn scene. * Rainbow pantyhose fits this **teen** when she is fucked Visitors who are not 18 years old, please leave this website now. This website is for Adults only. Enjoy It.

Exploited Black **Teens**, **Teen** Titans Hentai, **Teen** Thongs, **Teen** Thongs, Galleries

home.tiscali.cz/trouya/teen-girls/exploited-black-teens.html ▾

Horny **teens** dog breeds **teen** thongs, hot **teens** in g strings, milfs **teen** thong galleries, horse cum zoophilia mature rape mature women cum milfs **teen** thongs, milfhunter bestiality bestiality exploited black **teens**. Topless **teens** fucking cum hot **teens** in g strings.

Big **Teen** Tube - ube Porn **Teen**, **teen** webcam, **teen** nudes, **teen** lesbians

bigteentube.me/page-3 ▾

Young **teen** porn videos feature beautiful talented **teen** models that show their love to hard and tasty dicks.

teens love old; **teens** molested and loving it; **teens** kissing **teens**, **teens**

www.alienapparatus.com/images/.../757/1993.html ▾

How **teens** in thogs near **teens** in thong; **teens** in thong bikinis about **teens** in thong forums, **teens** in thong panties; **teens** in thongs to **teens** in thongs and bras from **teens** in thongs and g strings; **teens** in thongs and g-strings to **teens** in thongs and nude **teens**.

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Figure: 'teens', ElasticSearch (BM25) on CommonCrawl 04/2017

Why Care: Learning-to-rank

205.000.000 Results

Date ▾

Open links in new tab



Teens Definition & Meaning - Merriam-Webster

<https://www.merriam-webster.com/dictionary/teens> ▾

The meaning of **TEENS** is the numbers 13 to 19 inclusive; specifically : the years 13 to 19 in a lifetime or century. How to use **teens** in a sentence.

TEENS | meaning, definition in Cambridge English Dictionary

<https://dictionary.cambridge.org/dictionary/english/teens> ▾

teens definition: 1. A person's teens are the period in which they are aged between 13 and 19; 2. the range of.... Learn more.

Teens - definition of teens by The Free Dictionary

<https://www.thefreedictionary.com/teens> ▾

1. teens a. The numbers 10 through 19 or 13 through 19. b. The 10th through 19th items, in a series or scale: The temperature was in the low **teens**. The numbers 10 through 19 or 13

Teens | ARD Mediathek | ARD Mediathek

<https://www.ardmediathek.de/teens>

Teens. Liebe, Musik, Klimaschutz, Challenges & Menschen hautnah – Themen, die dich bewegen! Videos, Dokus, Filme & Serien zum Bingewatchen. Liste mit 9 Einträgen. 28 Min. ...

Cute Teens Photos and Premium High Res Pictures

<https://www.gettyimages.com/photos/cute-teens> ▾

Browse 84,731 cute teens stock photos and images available, or search for cute girls to find more great stock photos and pictures. sweet day wih my son - cute teens stock pictures, rc images. boys and girls - cute teens ...

A*Teens – Wikipedia

https://de.wikipedia.org/wiki/A*Teens ▾

Marie, Amit, Dhani und Sara wurden 1998 im Rahmen eines ABBA-Projektes in einer Tanzschule durch die Plattenfirma Stockholm Records (heute: Universal Music/Vivendi) gecastet. I

16,996 Teens Bathing Suit Premium High Res Photos - Getty Images

<https://www.gettyimages.com/photos/teens-bathing-suit> ▾

Browse 16,996 teens bathing suit stock photos and images available, or start a new search to explore more stock photos and images. splashing through the waves - teens bathing suit

Video shows Aboriginal teens tear-gassed, stripped naked at ...

[https://globalnews.ca/video/2848385/video-shows-aboriginal-teens-tear...](https://globalnews.ca/video/2848385/video-shows-aboriginal-teens-tear-...) ▾

26.07.2016 · Watch Video shows Aboriginal teens tear-gassed, stripped naked at Australian detention facility Video Online, on GlobalNews.ca

Top 18+ Teens OnlyFans Accounts Featuring 18+ Talent in 2022

<https://philadelphiaweekly.com/onlyfans-teens> ▾

14.02.2022 · Best Teens OnlyFans Rated and Reviewed. Best teens OnlyFans overall – Bella Bumzy. Hardcore, daily content – Kacy Black. Great OnlyFans solo videos – Sam Slayre.

Figure: 'teens', Microsoft Bing, SafeSearch: Off



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Why should a web search engine care about adult content?

- ▶ Cultural reasons → reputational risk
- ▶ Legal reasons → financial risk
- ▶ Moral reasons → controversial, compare e.g. Stanley et al. 2018 [1]:
“Boys’ perpetration of sexual coercion and abuse was significantly associated with regular viewing of online pornography.”
- ▶ Enable the user to choose by personal preference

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Other approaches to classify adult content

Manually compiled dictionaries and feature engineering

- ▶ WebGuard, Hammami et al., 2006 [2] use 14 features and a decision tree classifier. Feature examples:
 - ▶ number of sexually explicit words
 - ▶ number of images whose name include explicit words
- ▶ Largillier et al. 2015 [3] use 12 features and a decision forest for classification, some new features:
 - ▶ terms that are usual categories of pornographic websites
 - ▶ names of 8825 adult entertainment industry actors

Bag-of-words document representation

- ▶ Du et al., 2003 [4] use a k-nearest neighbor approach based on vectors of word frequencies. A document is tagged as adult if cosine similarity to average of top 50% of adult training vectors is above a predetermined threshold → additional hyperparameters

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Objectives

- ▶ Classification: Assign class labels adult versus non-adult to a home page of a domain
- ▶ Classification based on textual content of web page only
- ▶ Prefer simple and model based over more complex approaches

Evaluated Classification Algorithms

Evaluate two established and simple text classification approaches

- ▶ Multinomial naive Bayes (MNB)
- ▶ Logistic regression (LogReg)

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Informal Characterization

Multinomial Naive Bayes

- ▶ Document is represented as a set of words together with word frequencies → bag-of-words representation
- ▶ Learns joint probability function by estimating relative frequencies
- ▶ Assigned class = $\arg \max_c P(c) \prod_{w \in d} P(w|c)$
- ▶ Generative, linear classifier

Logistic Regression

- ▶ Document is represented as a vector of word frequencies → bag-of-words representation
- ▶ Learns weights by minimizing cross-entropy loss function
- ▶ Chooses class adult if $\beta^T \mathbf{d} + \theta > 0$
- ▶ Discriminative, linear classifier

Adult training samples

- ▶ Perform web search on major search engines using relevant keywords (like 'porno') → list of URLs
- ▶ Remove path from URLs and delete duplicate URLs
- ▶ Fetch home pages and remove html tags
- ▶ Keep only German and English language and size > 500 bytes → 217 adult documents

Non-Adult training samples

- ▶ Choose 5000 biggest (number of pages) domains from a crawl of German web
- ▶ Same processing as above → 4351 non-adult documents

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Multinomial Naive Bayes

Create a vocabulary for the training corpus, where each entry contains word w_i as key, class label and probabilities

$$P(w_i|c) = \frac{\text{count}(w_i, c) + 1}{\sum_{w \in V} (\text{count}(w, c) + 1)}$$

Logistic Regression

- ▶ Feature vectors are the document vectors of word frequencies in the training corpus
- ▶ Use only the 2000 features with highest χ^2 statistics
- ▶ Stochastic gradient decent (SGD) to determine weights β and θ

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Computational performance of classification

- ▶ ~~Parsing of web page (remove html tags)~~
- ▶ Tokenization
- ▶ MNB: Vocabulary lookups to retrieve probabilities
- ▶ LogReg: Number of features

Some numbers

- ▶ MNB: Average computation time 2.5 ms on single 2.4GHz i3-7100U core (C-implementation)
- ▶ LogReg: No comparable values because of python scikit-learn environment → expected to be faster than MNB (no vocabulary lookups)

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Confusion Matrix

		true values		
		adult	\neg adult	
out	adult	210	29	precision
	\neg adult	7	4322	
recall		$\frac{210}{210+7}=96.8\%$	$\frac{4322}{4322+29}=99.3\%$	$\frac{210}{210+29}=87.9\%$
				$\frac{4322}{4322+7}=99.8\%$

Table: MNB: Confusion matrix for 10-fold cross-validation including micro-average precision and recall.

		true values		
		adult	\neg adult	
out	adult	195	6	precision
	\neg adult	22	4345	
recall		$\frac{195}{195+22}=89.9\%$	$\frac{4345}{4345+6}=99.9\%$	$\frac{195}{195+6}=97.0\%$
				$\frac{4345}{4345+22}=99.5\%$

Table: LogReg: Confusion matrix for 10-fold cross-validation including micro-average precision and recall.

Misclassification Rates

Misclassification rate = $1 - \text{recall}$

method	adult	\neg adult
MNB	3.2%	0.7%
LogReg	10.1%	0.1%
Largillier et al. [3]	2.2%	4.7%
Du et al. [4], threshold 0.14	1.2%	0.9%

Table: Comparison of misclassification rates. Note that reported results from [3] and [4] are based on different training data and hence comparability is limited.

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Observations

- ▶ Both evaluated simple, text based classifiers perform well, but MNB shows lower adult misclassification rate
- ▶ Most documents misclassified by MNB are “border” cases e.g. `www.erotikforum.at` → labeling training data is subjective

Possible Improvements

- ▶ Instead of using only the home page to classify a domain, defer classification until more pages are classified and perform some kind of majority vote
- ▶ Extend pure MNB approach by adding additional features like image count, text quality (e.g. *perplexity*)
- ▶ More powerful models like SVMs

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- ▶ Commercial / public search engines have to address the issue of adult content
- ▶ Application of *learning-to-rank* can be a first line of defence against ambiguous search terms
- ▶ Simple text classifiers achieve low misclassification rates
- ▶ Multinomial naive Bayes classifiers shows best performance compared to logistic regression in respect to adult miss rate

Thank you for listening!

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 Thomas Largillier, Guillaume Peyronnet, and Sylvain Peyronnet. “Efficient filtering of adult content using textual information.” In: *arXiv preprint arXiv:1512.00198* (2015).

 Rongbo Du, Reihaneh Safavi-Naini, and Willy Susilo. “Web filtering using text classification.” In: *The 11th IEEE International Conference on Networks, 2003. ICON2003*. IEEE. 2003, pp. 325–330.