# YouTube spam detection

## Artificial Intelligence for CyberSecurity

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# Dataset and goal

Total of 1956 YouTube comments from 5 different (famous) musical videos[1] with the following features:

- Comment ID
- Author
- Date
- Content
- Class

[1] https://archive.ics.uci.edu/dataset/380/youtube+spam+collection

# Dataset and goal

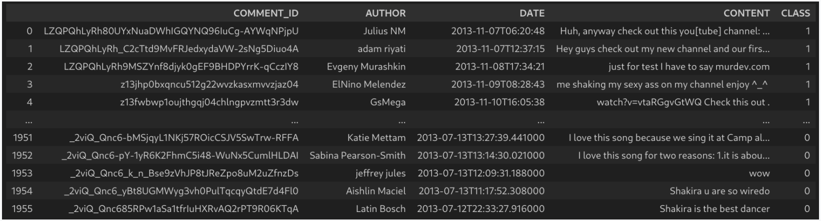
Total of 1956 YouTube comments from 5 different (famous) musical videos[1] with the following features:

- Comment ID
- Author
- Date
- Content
- Class

Goal: recognize and differentiate between legitimate (ham) comments and spam comments!

[1] https://archive.ics.uci.edu/dataset/380/youtube+spam+collection

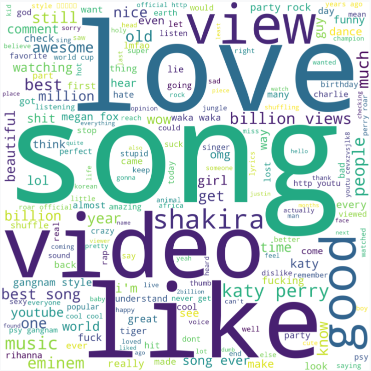
# Example entries



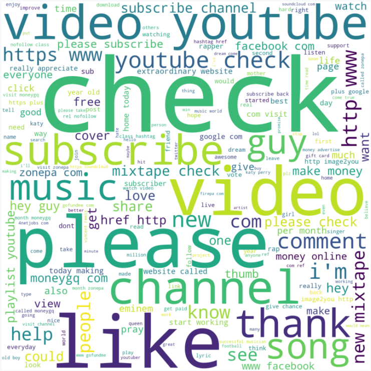
| | COMMENT_ID | AUTHOR | DATE | CONTENT | CLASS |
|---|---|---|---|---|---|
| 0 | LZQPQhLyRh80UYxNuaDWhIGQYNQ96IuCg-AYWqNPjpU | Julius NM | 2013-11-07T06:20:48 | Huh, anyway check out this you[tube] channel: ... | 1 |
| 1 | LZQPQhLyRh_C2cTtd9MvFRJedxydaVW-2sNg5Diuo4A | adam riyati | 2013-11-07T12:37:15 | Hey guys check out my new channel and our firs... | 1 |
| 2 | LZQPQhLyRh9MSZYnf8djyk0gEF9BHDPYrrK-qCczIY8 | Evgeny Murashkin | 2013-11-08T17:34:21 | just for test I have to say murdev.com | 1 |
| 3 | z13jhp0bxqncu512g22wvzkasxmvvzjaz04 | ElNino Melendez | 2013-11-09T08:28:43 | me shaking my sexy ass on my channel enjoy ^_^ | 1 |
| 4 | z13fwbwp1oujthgqj04chlngpvzmtt3r3dw | GsMega | 2013-11-10T16:05:38 | watch?v=vtaRGgvGtWQ Check this out . | 1 |
| ... | ... | ... | ... | ... | ... |
| 1951 | _2viQ_Qnc6-bMSjqyL1NKj57ROicCSJV5SwTrw-RFFA | Katie Mettam | 2013-07-13T13:27:39.441000 | I love this song because we sing it at Camp al... | 0 |
| 1952 | _2viQ_Qnc6-pY-1yR6K2FhmC5i48-WuNx5CumlHLDAI | Sabina Pearson-Smith | 2013-07-13T13:14:30.021000 | I love this song for two reasons: 1.it is abou... | 0 |
| 1953 | _2viQ_Qnc6_k_n_Bse9zVhJP8tJReZpo8uM2uZfnzDs | jeffrey jules | 2013-07-13T12:09:31.188000 | wow | 0 |
| 1954 | _2viQ_Qnc6_yBt8UGMWyg3vh0PulTqcqyQtdE7d4Fl0 | Aishlin Maciel | 2013-07-13T11:17:52.308000 | Shakira u are so wiredo | 0 |
| 1955 | _2viQ_Qnc685RPw1aSa1tfrIuHXRvAQ2rPT9R06KTqA | Latin Bosch | 2013-07-12T22:33:27.916000 | Shakira is the best dancer | 0 |

Class equal to one indicates spam!

# Word cloud

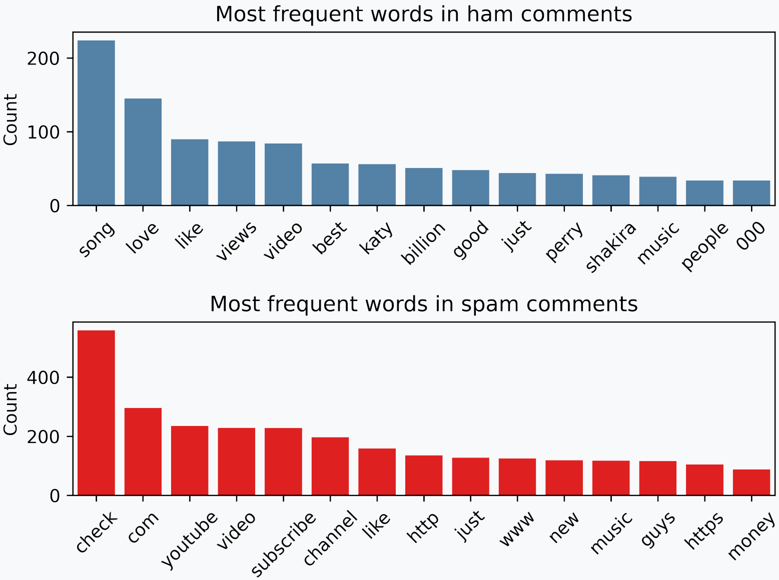


Ham word cloud



Spam word cloud

# Most frequent words

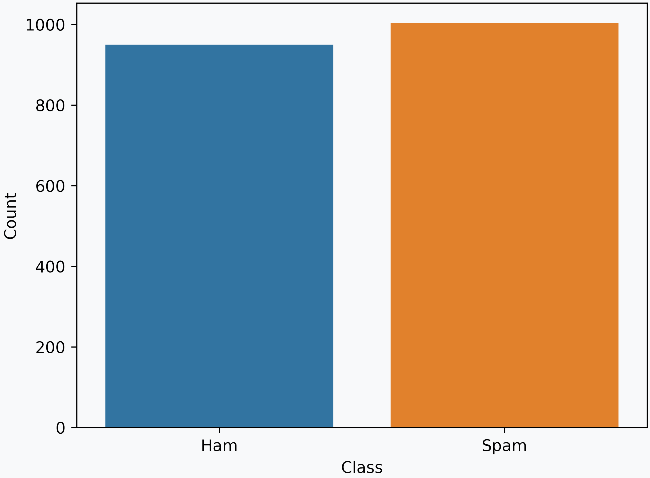


Most frequent words in ham comments

Most frequent words in spam comments

# Balanced dataset

Classes are (basically) balanced!



# Cleaning

- Checked for null values (only a few in date)
- Removed useless features (comment ID, author and date)
- Removed duplicates (only 3 duplicates, which affected the balance positively)
- Replaced HTML tags and entities in comments (e.g. replaced <br /> with \n)

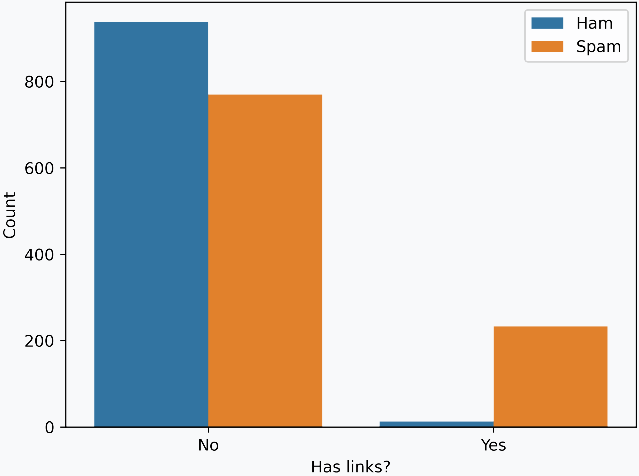
# Adding useful features

Tried to extract possible features that may indicate a spamming behaviour:

- Links
- YouTube links (spamming one's channel)
- Use of non-ASCII characters (e.g. emojis)
- Number of characters, words, and sentences
- Number of uppercase letters

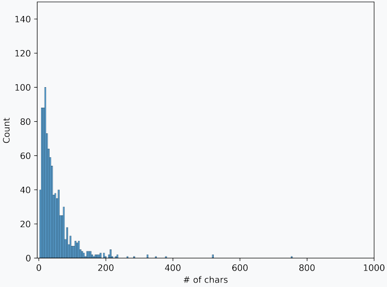
# Adding useful features - Links

Presence of links may indicate spam:

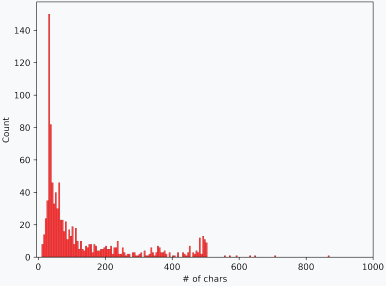


# Adding useful features - Characters

Spam comments have a much higher peak, a longer tail, and a second smaller peak at about 500 characters.

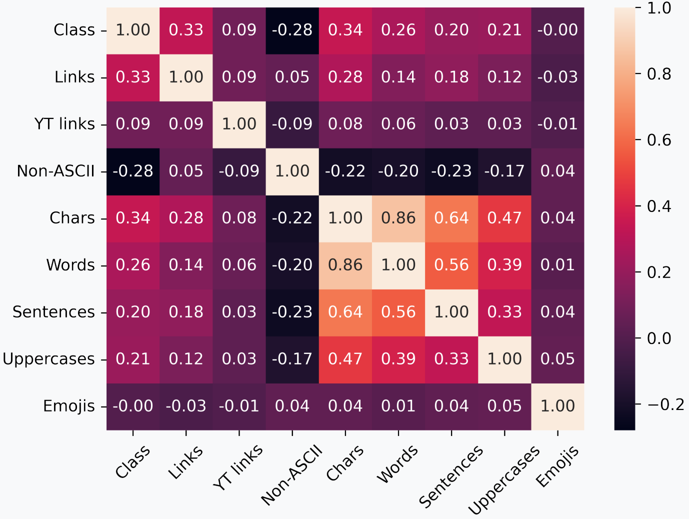


Ham



Spam

# Adding useful features - Heatmap



# Approach

Classification has been performed with 4 classifiers:

- Support Vector Machine
- Multinomial naïve Bayes
- Decision tree
- Random tree

and with 3 different preprocessings:

- Stemming with Porter stemmer
- Stemming with Snowball stemmer
- Lemmatization

# Performance evaluation

Results obtain from K-fold (10 folds):

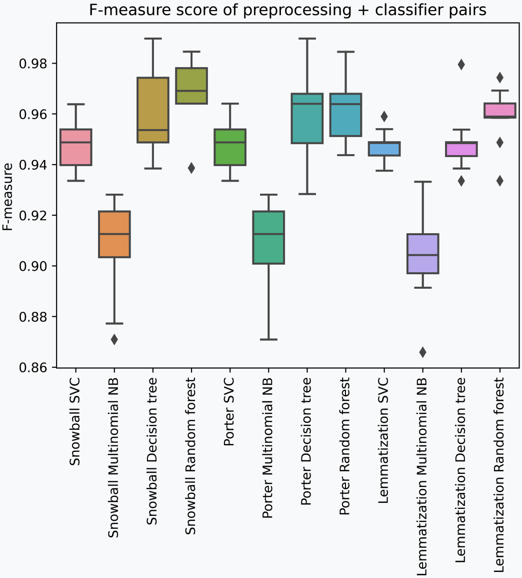
| | SVM | Multinomial NB | Decision tree | Random forest |
|---|---|---|---|---|
| **Snowball** | 0.948 | 0.908 | 0.957 | 0.964 |
| **Porter** | 0.949 | 0.907 | 0.957 | 0.962 |
| **Lemmatization** | 0.947 | 0.903 | 0.949 | 0.958 |

F-measure

| | SVM | Multinomial NB | Decision tree | Random forest |
|---|---|---|---|---|
| **Snowball** | 0.948 | 0.908 | 0.958 | 0.964 |
| **Porter** | 0.949 | 0.907 | 0.96 | 0.964 |
| **Lemmatization** | 0.947 | 0.904 | 0.949 | 0.961 |

Accuracy

# Performance evaluation



# Testing the null hypothesis

The random forest classifier has performed the best, whereas the preprocessing has a much smaller impact on final results. Wilcoxon test can be used to determine if there is a statistical difference between preprocessing methods (with a fixed classifier).

| **Preprocessing pair** | **P-value** |
|---|---|
| Snowball - Porter | 0.4962 |
| Snowball - Lemmatization | 0.1934 |
| Porter - Lemmatization | 0.1055 |

Random forest with different preprocessing

Using the conventional acceptance of statistical significance at 0.05 (5%), we confirm the null hypothesis: *the difference between the three proprocessing methods is not statistically significant!*

# Performance evaluation - Other results

In general, Wilcoxon test allows determining that in this dataset, for the tested classifiers and preprocessing algorithms:

- The use of a different preprocessing is usually not significant, but it is for the decision tree classifier
- The use of a different classifier is almost always significant

# Conclusions and future work

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- The best classifier turned out to be the Random forest model. As the classifier has very good performances, the initial goal can be considered achieved
- The use of K-fold and of the Wilcoxon test ensure that results are statistically significant

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- The use of K-fold and of the Wilcoxon test ensure that results are statistically significant

Improvements/future work:

- Trying other algorithms and/or preprocessing methods, which may lead to even higher performances
- The dataset is not large at all. To completely ensure that results can be trusted, it would be needed to use a much larger dataset (possibly with at least tens of thousand of comments). Unfortunately, no such dataset was found online