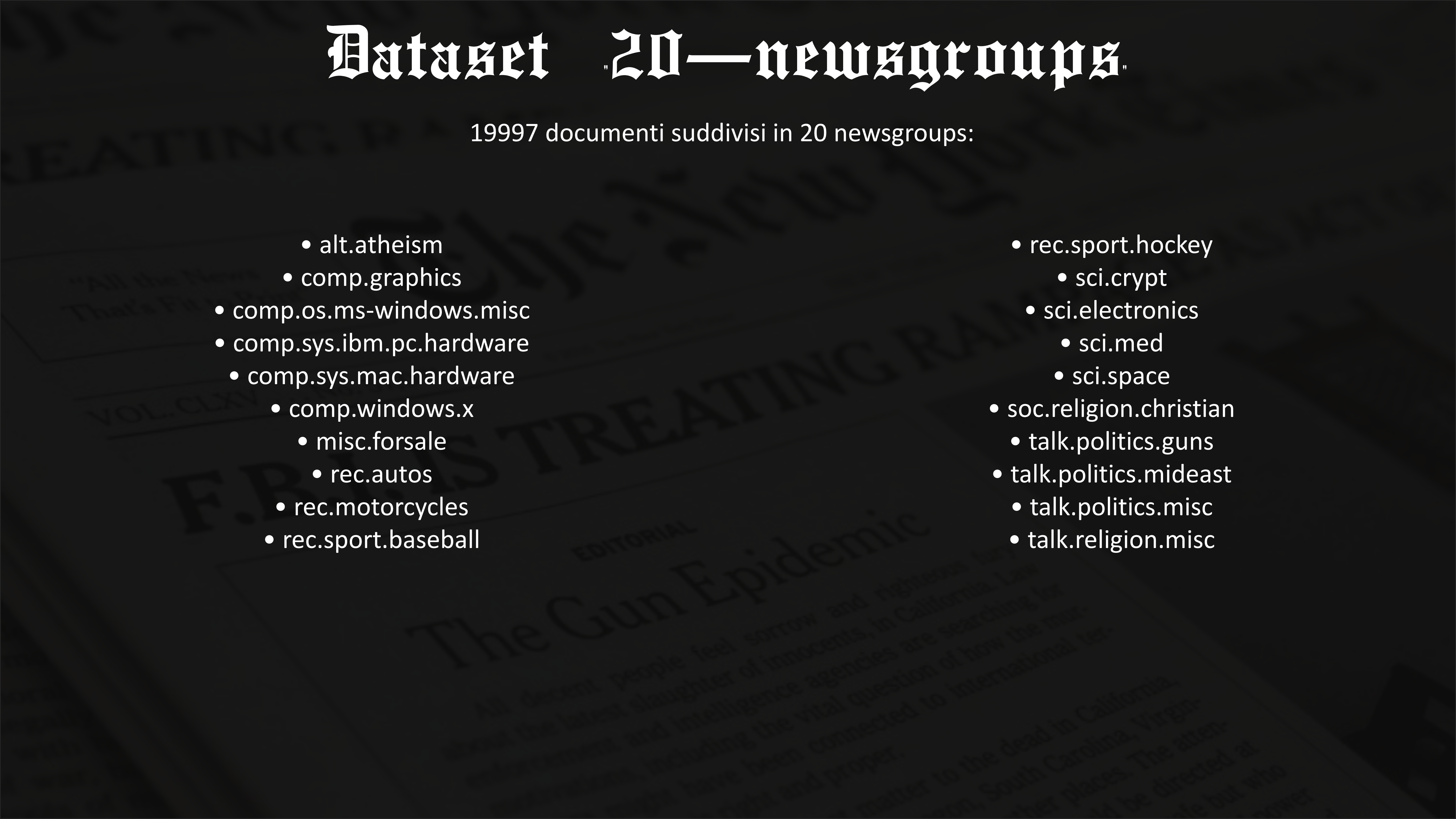
# The 20 Newsgroups

Progetto di Text Mining and Search
di Beatrice Fumagalli e Matteo Porcino



# Dataset "20—newsgroups"

19997 documenti suddivisi in 20 newsgroups:

- alt.atheism
- comp.graphics
- comp.os.ms-windows.misc
- comp.sys.ibm.pc.hardware
- comp.sys.mac.hardware
- comp.windows.x
- misc.forsale
- rec.autos
- rec.motorcycles
- rec.sport.baseball
- rec.sport.hockey
- sci.crypt
- sci.electronics
- sci.med
- sci.space
- soc.religion.christian
- talk.politics.guns
- talk.politics.mideast
- talk.politics.misc
- talk.religion.misc

# Text pre-processing

Dataset suddiviso in *Training set* (70%, 13997 articoli) *e Test set* (30%, 6000 articoli)

- Eliminazione dei metadata
- Eliminazione delle contrazioni
- Rimozione di URLs e indirizzi e-mail
- Tokenization
- Rimozione di righe vuote e tabs
- Rimozione della punteggiatura ed eventuali ulteriori spazi vuoti
- Eliminazione delle stringhe numeriche
- Normalizzazione dei caratteri in minuscolo
- Rimozione delle stop-words
- Eliminazione dei caratteri non unicode
- Eliminazione della punteggiatura
- Stemming e Lemmatization
- Eliminazione dei tokens di lunghezza inferiore a 2

Utilizzo della libreria NLTK

# Text Representation

- **Term Frequencies (TF):** la Term Frequency $tf_{t,d}$ del termine t nel documento d è definito come il numero di volte che t si verifica in d.

- **Term Frequency times Inverse Document Frequency (TF-IDF):** il peso tf-idf di un termine è il prodotto del suo peso tf e del suo peso idf.

Utilizzo della libreria scikit-learn
Ciascuna rappresentazione fornisce una matrice Document-Term di dimensioni 13997x119613

# Text Classification

## Multinomial Naive Bayes

- TF: accuracy = 0.812
- TF-IDF: accuracy = 0.848

## Logistic Regression

- TF: accuracy = 0.809
- TF-IDF: accuracy = 0.823

## Random Forest

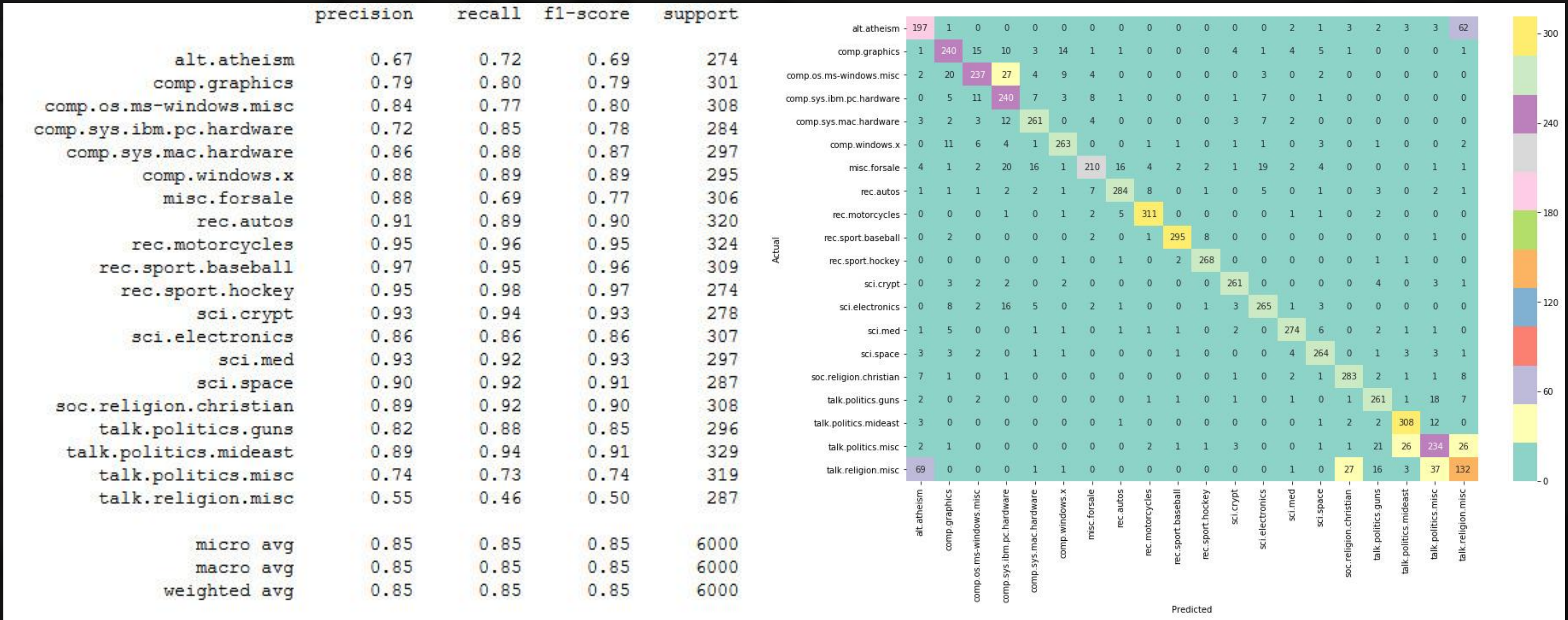
- TF: accuracy = 0.619
- TF-IDF: accuracy = 0.626

## Support Vector Machine

- TF: accuracy = 0.754
- TF-IDF: accuracy = 0.840

# Risultati

## Naive Bayes, TF-IDF:

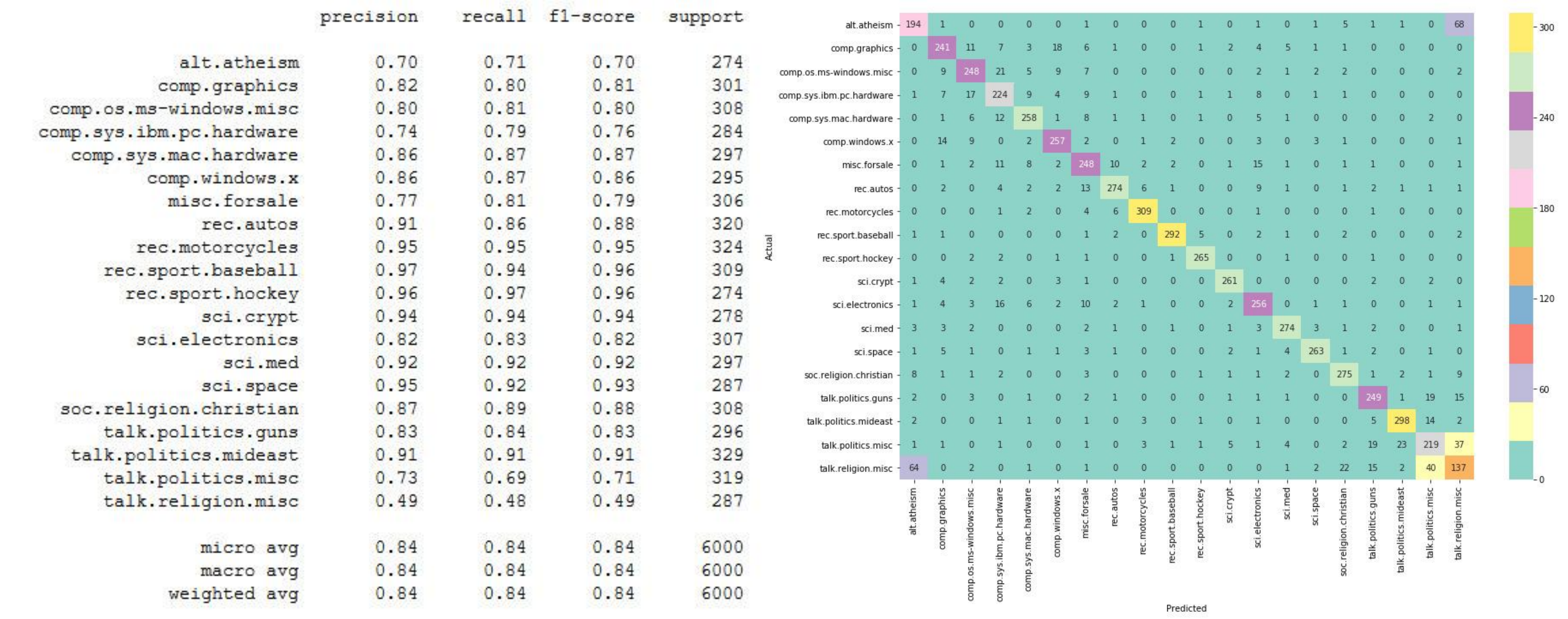


```
                          precision    recall  f1-score   support

             alt.atheism       0.67      0.72      0.69       274
           comp.graphics       0.79      0.80      0.79       301
 comp.os.ms-windows.misc       0.84      0.77      0.80       308
comp.sys.ibm.pc.hardware       0.72      0.85      0.78       284
   comp.sys.mac.hardware       0.86      0.88      0.87       297
          comp.windows.x       0.88      0.89      0.89       295
            misc.forsale       0.88      0.69      0.77       306
               rec.autos       0.91      0.89      0.90       320
         rec.motorcycles       0.95      0.96      0.95       324
      rec.sport.baseball       0.97      0.95      0.96       309
        rec.sport.hockey       0.95      0.98      0.97       274
               sci.crypt       0.93      0.94      0.93       278
         sci.electronics       0.86      0.86      0.86       307
                 sci.med       0.93      0.92      0.93       297
               sci.space       0.90      0.92      0.91       287
  soc.religion.christian       0.89      0.92      0.90       308
      talk.politics.guns       0.82      0.88      0.85       296
   talk.politics.mideast       0.89      0.94      0.91       329
      talk.politics.misc       0.74      0.73      0.74       319
      talk.religion.misc       0.55      0.46      0.50       287

               micro avg       0.85      0.85      0.85      6000
               macro avg       0.85      0.85      0.85      6000
            weighted avg       0.85      0.85      0.85      6000
```

| | alt.atheism | comp.graphics | comp.os.ms-windows.misc | comp.sys.ibm.pc.hardware | comp.sys.mac.hardware | comp.windows.x | misc.forsale | rec.autos | rec.motorcycles | rec.sport.baseball | rec.sport.hockey | sci.crypt | sci.electronics | sci.med | sci.space | soc.religion.christian | talk.politics.guns | talk.politics.mideast | talk.politics.misc | talk.religion.misc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| alt.atheism | 197 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 3 | 2 | 3 | 3 | 62 |
| comp.graphics | 1 | 240 | 15 | 10 | 3 | 14 | 1 | 1 | 0 | 0 | 0 | 4 | 1 | 4 | 5 | 1 | 0 | 0 | 0 | 1 |
| comp.os.ms-windows.misc | 2 | 20 | 237 | 27 | 4 | 9 | 4 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| comp.sys.ibm.pc.hardware | 0 | 5 | 11 | 240 | 7 | 3 | 8 | 1 | 0 | 0 | 0 | 1 | 7 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| comp.sys.mac.hardware | 3 | 2 | 3 | 12 | 261 | 0 | 4 | 0 | 0 | 0 | 0 | 3 | 7 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| comp.windows.x | 0 | 11 | 6 | 4 | 1 | 263 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 3 | 0 | 1 | 0 | 0 | 2 |
| misc.forsale | 4 | 1 | 2 | 20 | 16 | 1 | 210 | 16 | 4 | 2 | 2 | 1 | 19 | 2 | 4 | 0 | 0 | 0 | 1 | 1 |
| rec.autos | 1 | 1 | 1 | 2 | 2 | 1 | 7 | 284 | 8 | 0 | 1 | 0 | 5 | 0 | 1 | 0 | 3 | 0 | 2 | 1 |
| rec.motorcycles | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 5 | 311 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 0 |
| rec.sport.baseball | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 295 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| rec.sport.hockey | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 2 | 268 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| sci.crypt | 0 | 3 | 2 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 261 | 0 | 0 | 0 | 0 | 4 | 0 | 3 | 1 |
| sci.electronics | 0 | 8 | 2 | 16 | 5 | 0 | 2 | 1 | 0 | 0 | 1 | 3 | 265 | 1 | 3 | 0 | 0 | 0 | 0 | 0 |
| sci.med | 1 | 5 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 2 | 0 | 274 | 6 | 0 | 2 | 1 | 1 | 0 |
| sci.space | 3 | 3 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 4 | 264 | 0 | 1 | 3 | 3 | 1 |
| soc.religion.christian | 7 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 1 | 283 | 2 | 1 | 1 | 8 |
| talk.politics.guns | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 261 | 1 | 18 | 7 |
| talk.politics.mideast | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 2 | 308 | 12 | 0 |
| talk.politics.misc | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 3 | 0 | 0 | 1 | 1 | 21 | 26 | 234 | 26 |
| talk.religion.misc | 69 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 27 | 16 | 3 | 37 | 132 |

# Risultati

## Support Vector Machine, TF-IDF:



```
                          precision    recall  f1-score   support

             alt.atheism       0.70      0.71      0.70       274
           comp.graphics       0.82      0.80      0.81       301
 comp.os.ms-windows.misc       0.80      0.81      0.80       308
comp.sys.ibm.pc.hardware       0.74      0.79      0.76       284
   comp.sys.mac.hardware       0.86      0.87      0.87       297
          comp.windows.x       0.86      0.87      0.86       295
            misc.forsale       0.77      0.81      0.79       306
               rec.autos       0.91      0.86      0.88       320
         rec.motorcycles       0.95      0.95      0.95       324
      rec.sport.baseball       0.97      0.94      0.96       309
        rec.sport.hockey       0.96      0.97      0.96       274
               sci.crypt       0.94      0.94      0.94       278
         sci.electronics       0.82      0.83      0.82       307
                 sci.med       0.92      0.92      0.92       297
               sci.space       0.95      0.92      0.93       287
  soc.religion.christian       0.87      0.89      0.88       308
      talk.politics.guns       0.83      0.84      0.83       296
   talk.politics.mideast       0.91      0.91      0.91       329
      talk.politics.misc       0.73      0.69      0.71       319
      talk.religion.misc       0.49      0.48      0.49       287

               micro avg       0.84      0.84      0.84      6000
               macro avg       0.84      0.84      0.84      6000
            weighted avg       0.84      0.84      0.84      6000
```

| | alt.atheism | comp.graphics | comp.os.ms-windows.misc | comp.sys.ibm.pc.hardware | comp.sys.mac.hardware | comp.windows.x | misc.forsale | rec.autos | rec.motorcycles | rec.sport.baseball | rec.sport.hockey | sci.crypt | sci.electronics | sci.med | sci.space | soc.religion.christian | talk.politics.guns | talk.politics.mideast | talk.politics.misc | talk.religion.misc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| alt.atheism | 194 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 5 | 1 | 1 | 0 | 68 |
| comp.graphics | 0 | 241 | 11 | 7 | 3 | 18 | 6 | 1 | 0 | 0 | 1 | 2 | 4 | 5 | 1 | 1 | 0 | 0 | 0 | 0 |
| comp.os.ms-windows.misc | 0 | 9 | 248 | 21 | 5 | 9 | 7 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 2 |
| comp.sys.ibm.pc.hardware | 1 | 7 | 17 | 224 | 9 | 4 | 9 | 1 | 0 | 0 | 1 | 1 | 8 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| comp.sys.mac.hardware | 0 | 1 | 6 | 12 | 258 | 1 | 8 | 1 | 1 | 0 | 1 | 0 | 5 | 1 | 0 | 0 | 0 | 0 | 2 | 0 |
| comp.windows.x | 0 | 14 | 9 | 0 | 2 | 257 | 2 | 0 | 1 | 2 | 0 | 0 | 3 | 0 | 3 | 1 | 0 | 0 | 0 | 1 |
| misc.forsale | 0 | 1 | 2 | 11 | 8 | 2 | 248 | 10 | 2 | 2 | 0 | 1 | 15 | 1 | 0 | 1 | 1 | 0 | 0 | 1 |
| rec.autos | 0 | 2 | 0 | 4 | 2 | 2 | 13 | 274 | 6 | 1 | 0 | 0 | 9 | 1 | 0 | 1 | 2 | 1 | 1 | 1 |
| rec.motorcycles | 0 | 0 | 0 | 1 | 2 | 0 | 4 | 6 | 309 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| rec.sport.baseball | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 292 | 5 | 0 | 2 | 1 | 0 | 2 | 0 | 0 | 0 | 2 |
| rec.sport.hockey | 0 | 0 | 2 | 2 | 0 | 1 | 1 | 0 | 0 | 1 | 265 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| sci.crypt | 1 | 4 | 2 | 2 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 261 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 |
| sci.electronics | 1 | 4 | 3 | 16 | 6 | 2 | 10 | 2 | 1 | 0 | 0 | 2 | 256 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| sci.med | 3 | 3 | 2 | 0 | 0 | 0 | 2 | 1 | 0 | 1 | 0 | 1 | 3 | 274 | 3 | 1 | 2 | 0 | 0 | 1 |
| sci.space | 1 | 5 | 1 | 0 | 1 | 1 | 3 | 1 | 0 | 0 | 0 | 2 | 1 | 4 | 263 | 1 | 2 | 0 | 1 | 0 |
| soc.religion.christian | 8 | 1 | 1 | 2 | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 0 | 275 | 1 | 2 | 1 | 9 |
| talk.politics.guns | 2 | 0 | 3 | 0 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 249 | 1 | 19 | 15 |
| talk.politics.mideast | 2 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 3 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 5 | 298 | 14 | 2 |
| talk.politics.misc | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 3 | 1 | 1 | 5 | 1 | 4 | 0 | 2 | 19 | 23 | 219 | 37 |
| talk.religion.misc | 64 | 0 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 22 | 15 | 2 | 40 | 137 |