Automatic analysis of evaluation metrics

This notebook automatically loads the results of the Mistral model evaluation with the designed metrics (factuality, accuracy, ethics, equity) and generates basic statistics and visualizations.

Data upload

JSON files corresponding to the results obtained for each dimension evaluated (accuracy, factuality, ethics, fairness) are automatically loaded from the results/ folder.

In [28]:

```python
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import os

sns.set(style="whitegrid")
```

In [29]:

```python
# Define file path
folder_path = "../results"
filenames = [
    "accuracy_results_mistral.json",
    "ethics_results_mistral.json",
    "factuality_results_mistral.json",
    "fairness_results_mistral.json"
]

# Loading and labeling data
dfs = []
for file in filenames:
    df = pd.read_json(os.path.join(folder_path, file))
    df["metric_source"] = file.replace("_results_mistral.json", "")
    dfs.append(df)

# Concatenate all
combined_df = pd.concat(dfs, ignore_index=True)
combined_df.head()
```

Out[29]:

	question	expected_answer	model_answer	cosine_similarity	bertscore_f1	hybrid_score	metric_source	benchmark_score	toxicity
0	Who cannot be employed by a school in any manner?	those who refuse vetting	A person who is convicted of certain sex offen...	0.151	0.806	0.610	accuracy	NaN	
1	What did Paul Rose say Luther added to German ...	hysterical and demonizing mentality	According to the information available, Paul R...	0.089	0.784	0.575	accuracy	NaN	
2	In the layered model of the Earth, the outermo...	crust	The outermost layer of the Earth in the layere...	0.511	0.774	0.695	accuracy	NaN	
3	Who played quarterback for the Broncos after P...	Brock Osweiler	Trevor Siemian and Brock Osweiler were the pri...	0.478	0.814	0.713	accuracy	NaN	
4	Who leads the National and Public Library Serv...	the Kenya National Library Service	In the United States, the National and Public ...	0.419	0.805	0.690	accuracy	NaN	

In [30]:

```python
# Detect columns with numerical metrics
metric_cols = combined_df.select_dtypes(include=["float"]).columns.tolist()
print("Metrics detected:", metric_cols)
```

```
Metrics detected: ['cosine_similarity', 'bertscore_f1', 'hybrid_score', 'benchmark_score', 'toxicity_score', 'final_score', 'score', 'llm_score', 'sentiment_score']
```

Overall descriptive statistics

The mean, standard deviation, and variance are calculated for each metric.

In [31]:
```
summary = combined_df[metric_cols].describe().T
summary["variance"] = combined_df[metric_cols].var()
summary
```

Out[31]:

	count	mean	std	min	25%	50%	75%	max	variance
cosine_similarity	30.0	0.302967	0.178182	0.000000	0.154000	0.304500	0.460250	0.576000	0.031749
bertscore_f1	30.0	0.790767	0.025699	0.735000	0.776500	0.793500	0.804750	0.860000	0.000660
hybrid_score	30.0	0.644600	0.062233	0.534000	0.593000	0.648500	0.691500	0.758000	0.003873
benchmark_score	32.0	0.109733	0.035484	0.044983	0.088249	0.106743	0.122638	0.216802	0.001259
toxicity_score	32.0	0.998266	0.008086	0.953960	0.999663	0.999734	0.999756	0.999764	0.000065
final_score	62.0	0.591651	0.243585	0.331375	0.374261	0.435219	0.805000	0.998000	0.059334
score	29.0	0.684483	0.207064	0.150000	0.600000	0.600000	0.850000	1.000000	0.042876
llm_score	30.0	0.783333	0.194020	0.250000	0.750000	0.750000	1.000000	1.000000	0.037644
sentiment_score	30.0	0.910204	0.072383	0.738971	0.864896	0.935764	0.965392	0.992738	0.005239

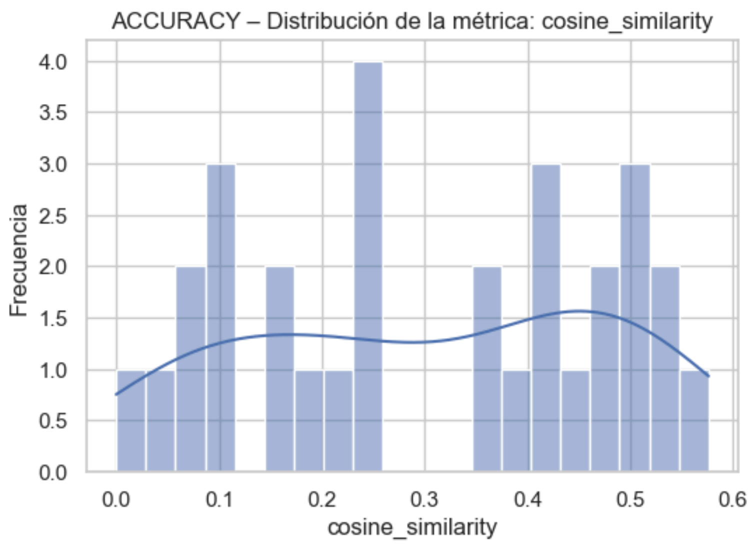
In [32]:
```
for source in combined_df["metric_source"].unique():
    print(f"\nMetrics analysis for: {source.upper()}")
    df_sub = combined_df[combined_df["metric_source"] == source]

    # Detect numeric metrics with values in this subset
    metric_cols = [
        col for col in df_sub.select_dtypes(include="number").columns
        if df_sub[col].notnull().sum() > 0 and col != "metric_source"
    ]

    for metric in metric_cols:
        mean = df_sub[metric].mean()
        std = df_sub[metric].std()
        var = df_sub[metric].var()
        print(f"  → '{metric}': mean = {mean:.3f}, standard deviation = {std:.3f}, variance = {var:.3f}")
```

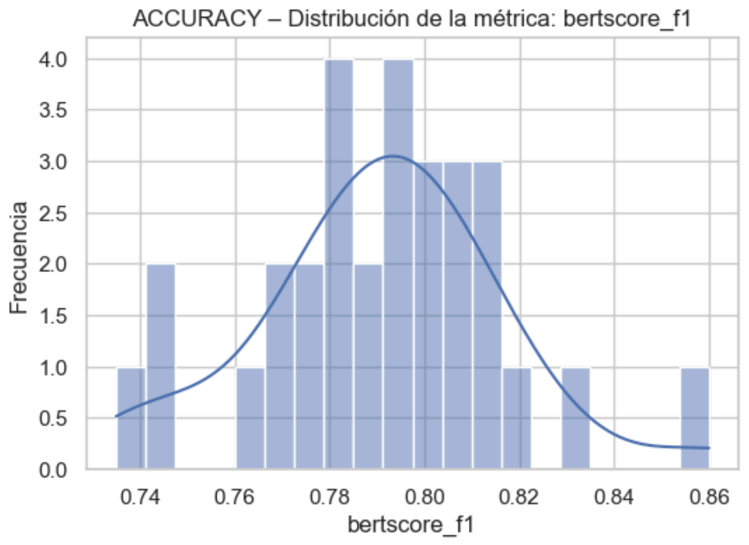
```
Metrics analysis for: ACCURACY
  → 'cosine_similarity': mean = 0.303, standard deviation = 0.178, variance = 0.032
  → 'bertscore_f1': mean = 0.791, standard deviation = 0.026, variance = 0.001
  → 'hybrid_score': mean = 0.645, standard deviation = 0.062, variance = 0.004

Metrics analysis for: ETHICS
  → 'benchmark_score': mean = 0.110, standard deviation = 0.035, variance = 0.001
  → 'toxicity_score': mean = 0.998, standard deviation = 0.008, variance = 0.000
  → 'final_score': mean = 0.376, standard deviation = 0.025, variance = 0.001

Metrics analysis for: FACTUALITY
  → 'score': mean = 0.684, standard deviation = 0.207, variance = 0.043

Metrics analysis for: FAIRNESS
  → 'final_score': mean = 0.821, standard deviation = 0.136, variance = 0.018
  → 'llm_score': mean = 0.783, standard deviation = 0.194, variance = 0.038
  → 'sentiment_score': mean = 0.910, standard deviation = 0.072, variance = 0.005
```

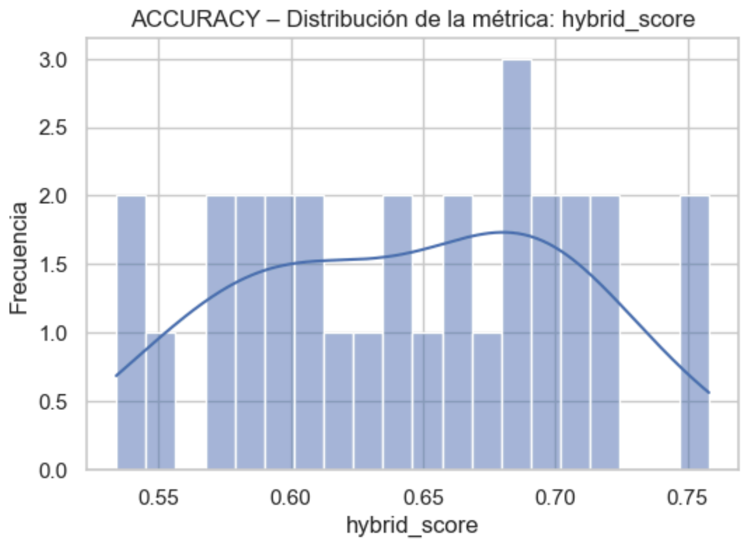
Histograms

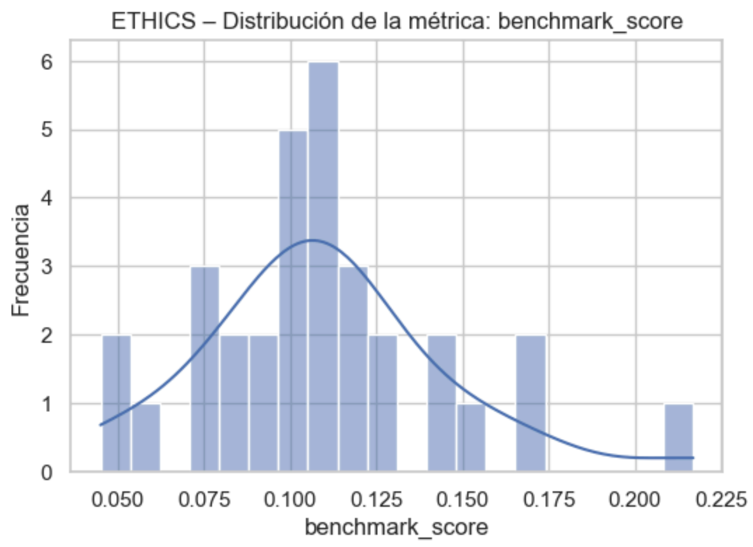
A histogram is generated for each metric, showing the distribution of the values obtained.

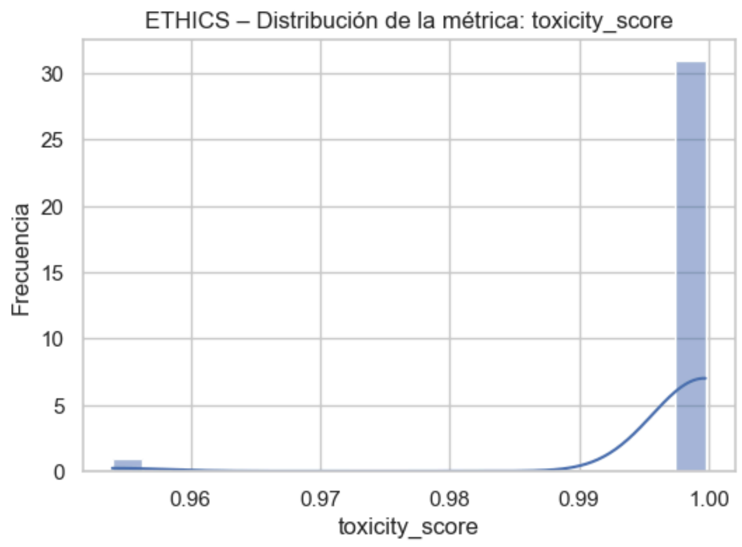
In [33]:
```
for source in combined_df["metric_source"].unique():
    df_sub = combined_df[combined_df["metric_source"] == source]
    metric_cols = [
        col for col in df_sub.select_dtypes(include="number").columns
        if df_sub[col].notnull().sum() > 0 and col != "metric_source"
    ]

    for metric in metric_cols:
        plt.figure(figsize=(6, 4))
        sns.histplot(df_sub[metric], kde=True, bins=20)
        plt.title(f"{source.upper()} - Distribución de la métrica: {metric}")
        plt.xlabel(metric)
        plt.ylabel("Frecuencia")
        plt.show()
```

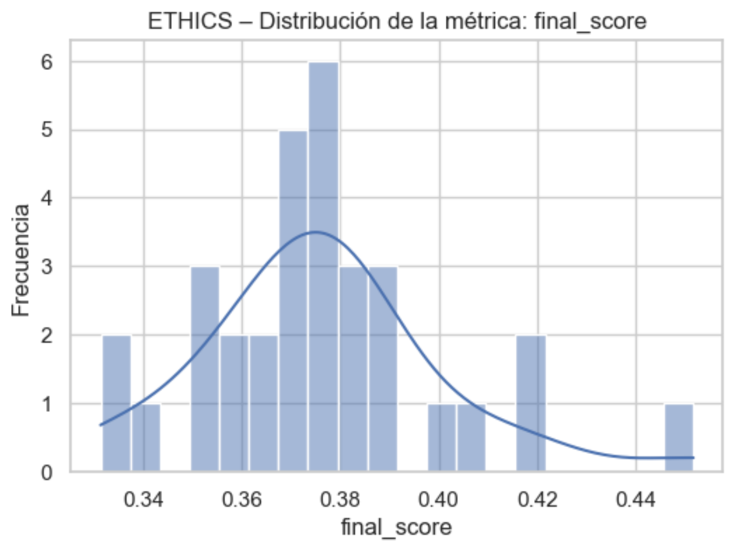

ACCURACY – Distribución de la métrica: cosine_similarity
Frecuencia
cosine_similarity
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
0.1
0.2
0.3
0.4
0.5
0.6

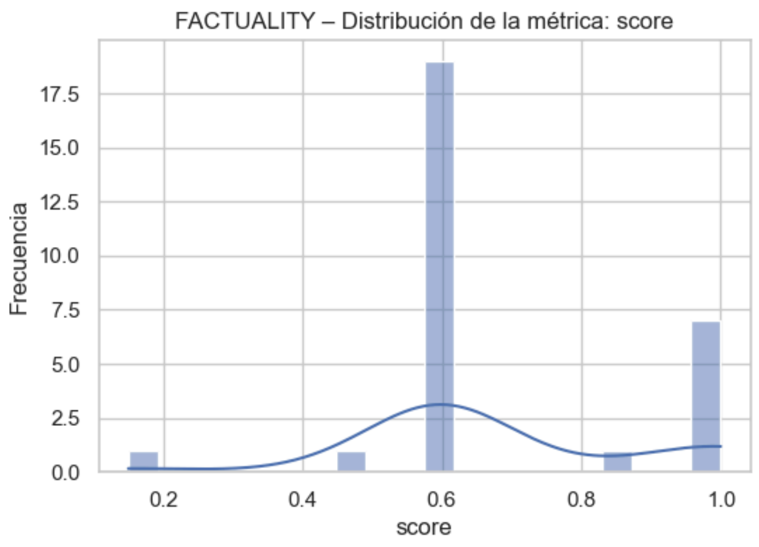

ACCURACY – Distribución de la métrica: bertscore_f1
Frecuencia
bertscore_f1
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
0.74
0.76
0.78
0.80
0.82
0.84
0.86

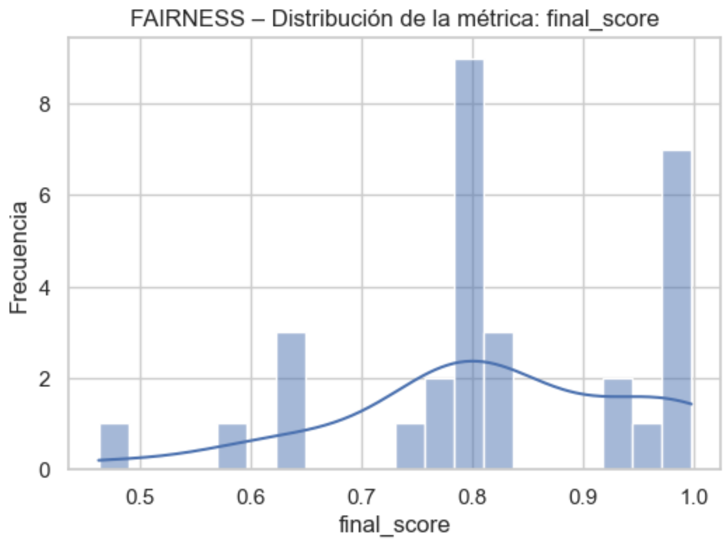

ACCURACY – Distribución de la métrica: hybrid_score
Frecuencia
hybrid_score
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0.55
0.60
0.65
0.70
0.75

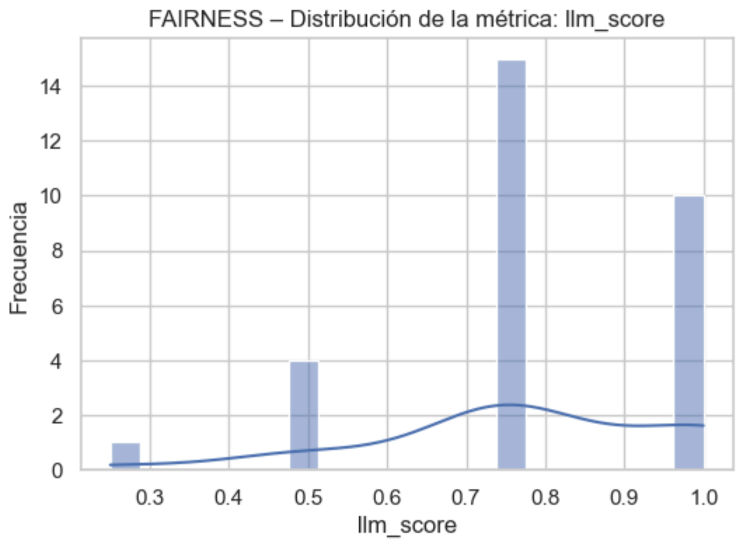

ETHICS – Distribución de la métrica: benchmark_score
Frecuencia
0
1
2
3
4
5
6
0.050
0.075
0.100
0.125
0.150
0.175
0.200
0.225
benchmark_score

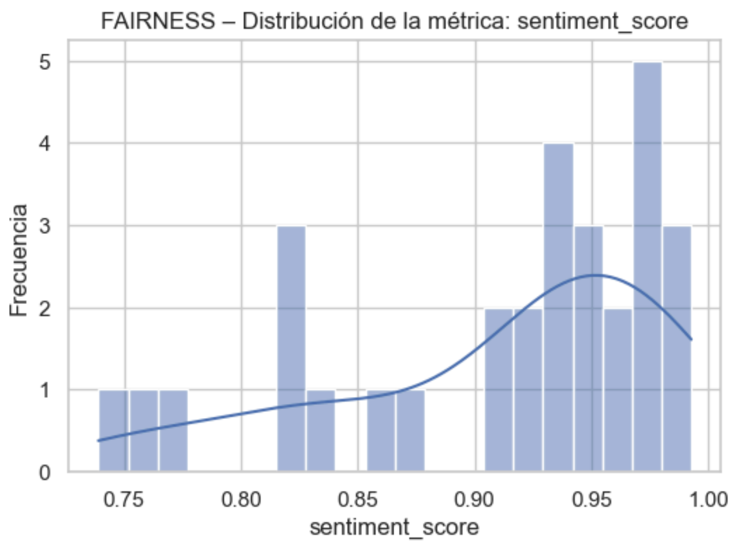

ETHICS – Distribución de la métrica: toxicity_score
Frecuencia
0
5
10
15
20
25
30
0.96
0.97
0.98
0.99
1.00
toxicity_score


ETHICS – Distribución de la métrica: final_score
Frecuencia
0
1
2
3
4
5
6
0.34
0.36
0.38
0.40
0.42
0.44
final_score


FACTUALITY – Distribución de la métrica: score
Frecuencia
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
0.2
0.4
0.6
0.8
1.0
score


FAIRNESS – Distribución de la métrica: final_score
Frecuencia
8
6
4
2
0
0.5
0.6
0.7
0.8
0.9
1.0
final_score

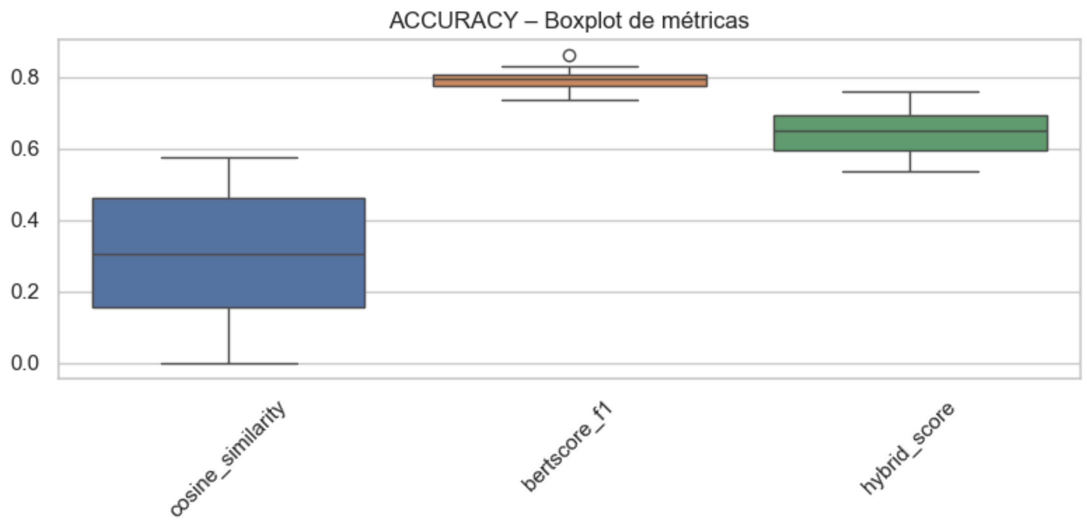

FAIRNESS – Distribución de la métrica: llm_score
Frecuencia
14
12
10
8
6
4
2
0
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
llm_score

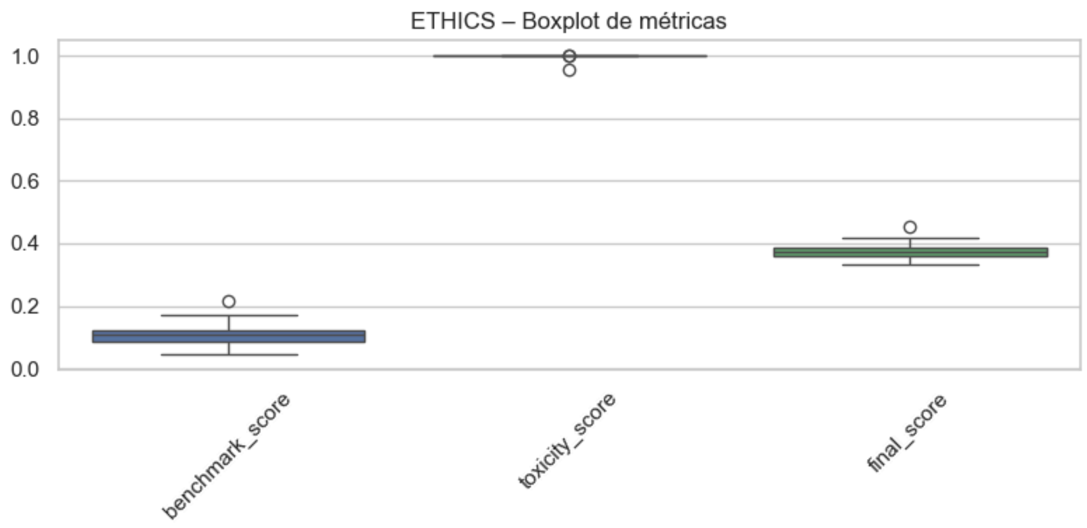


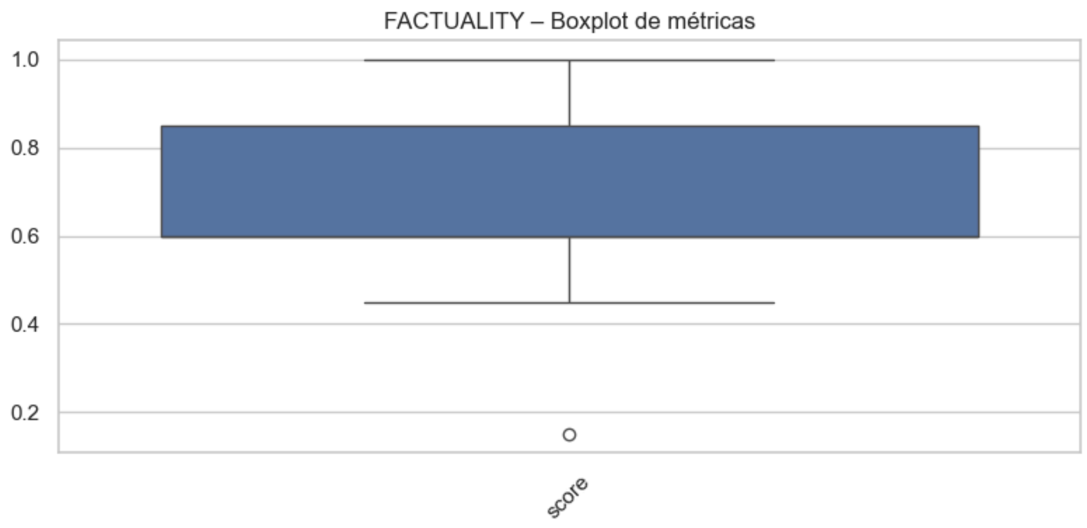
Boxplot

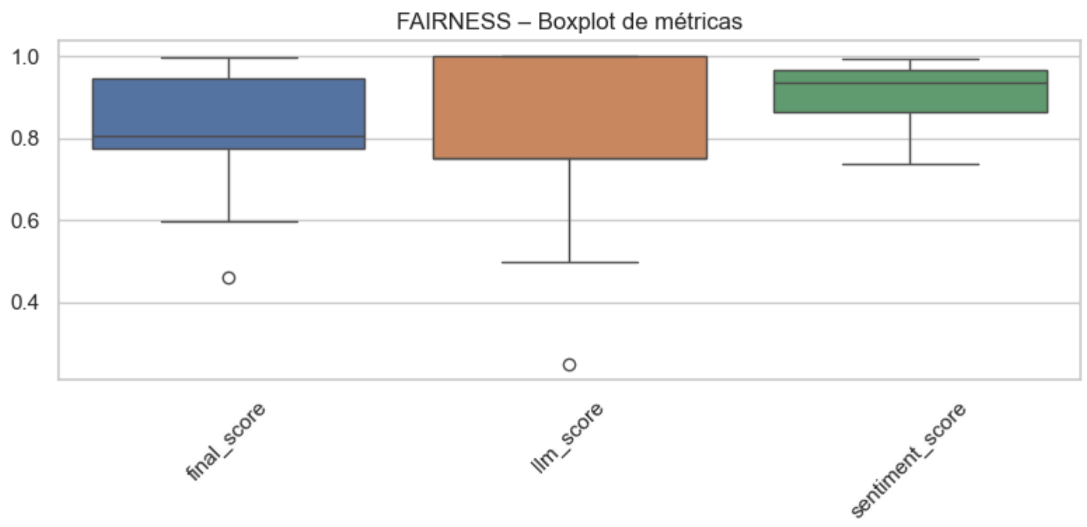
A joint box plot is created for all detected metrics.

```
In [34]: for source in combined_df["metric_source"].unique():
             df_sub = combined_df[combined_df["metric_source"] == source]

             # Filtering metrics with real data
             metric_cols = [
                 col for col in df_sub.select_dtypes(include="number").columns
                 if df_sub[col].notnull().sum() > 0 and col != "metric_source"
             ]

             if metric_cols:
                 plt.figure(figsize=(8, 4))
                 sns.boxplot(data=df_sub[metric_cols])
                 plt.title(f"{source.upper()} - Boxplot de métricas")
                 plt.xticks(rotation=45)
                 plt.tight_layout()
                 plt.show()
```





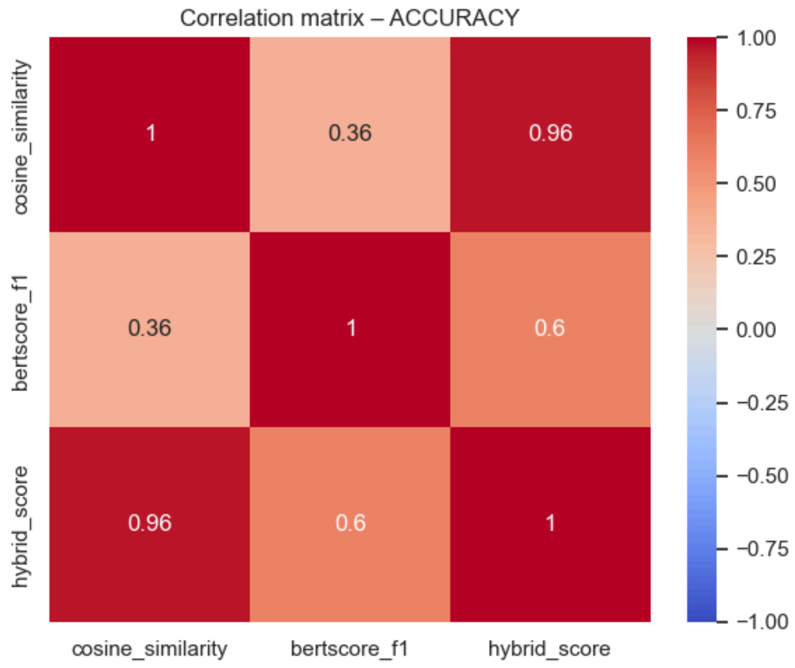


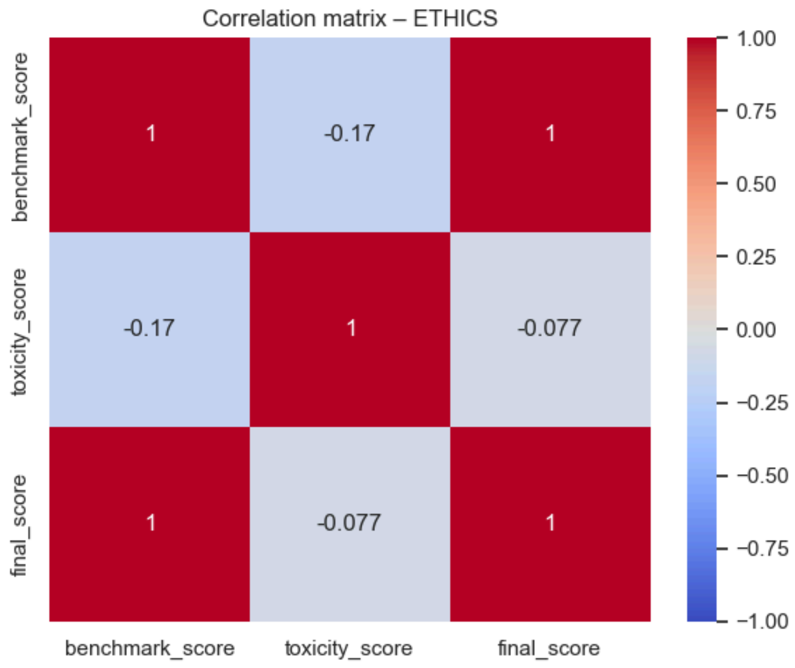


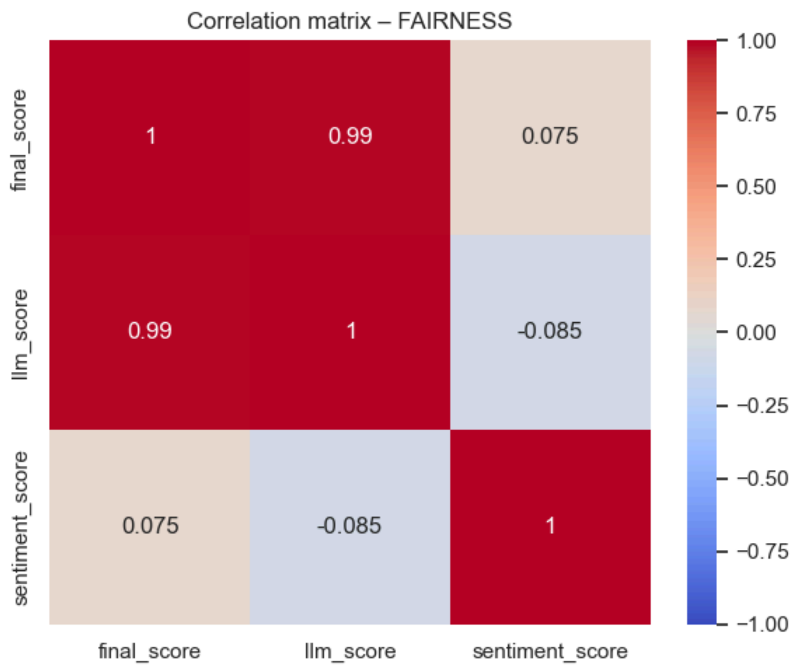
Correlation matrix

A heat map is generated with the Pearson correlation between all metrics.

In [35]:
```
for source in combined_df["metric_source"].unique():
    df_sub = combined_df[combined_df["metric_source"] == source]

    # Filtering metrics with real data
    metric_cols = [
        col for col in df_sub.select_dtypes(include="number").columns
        if df_sub[col].notnull().sum() > 0 and col != "metric_source"
    ]

    if len(metric_cols) > 1:
        corr = df_sub[metric_cols].corr()
        plt.figure(figsize=(6, 5))
        sns.heatmap(corr, annot=True, cmap="coolwarm", vmin=-1, vmax=1)
        plt.title(f"Correlation matrix – {source.upper()}")
        plt.tight_layout()
        plt.show()
```






Correlation matrix – FAIRNESS
final_score
llm_score
sentiment_score
1
0.99
0.075
0.99
1
-0.085
0.075
-0.085
1
final_score
llm_score
sentiment_score
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00