Automatic analysis of evaluation metrics

This notebook automatically loads the results of the Llama3 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 [1]:

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

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

In [2]:

```
# Define file path
folder_path = "../results"
filenames = [
    "accuracy_results_llama3.json",
    "ethics_results_llama3.json",
    "factuality_results_llama3.json",
    "fairness_results_llama3.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_llama3.json", "")
    dfs.append(df)

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

Out[2]:

	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	According to federal regulations, a convicted ...	0.202	0.805	0.624	accuracy	NaN	
1	What did Paul Rose say Luther added to German ...	hysterical and demonizing mentality	According to historical records, Paul L. Rose ...	0.128	0.786	0.589	accuracy	NaN	
2	In the layered model of the Earth, the outermo...	crust	Crust!	1.000	1.000	1.000	accuracy	NaN	
3	Who played quarterback for the Broncos after P...	Brock Osweiler	After Peyton Manning was benched, Brock Osweil...	0.682	0.870	0.814	accuracy	NaN	
4	Who leads the National and Public Library Serv...	the Kenya National Library Service	According to the Institute of Museum and Libra...	0.450	0.813	0.704	accuracy	NaN	

In [3]:

```
# 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 [4]:

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

Out[4]:

	count	mean	std	min	25%	50%	75%	max	variance
cosine_similarity	30.0	0.325133	0.212834	0.003000	0.160000	0.288500	0.409000	1.000000	0.045298
bertscore_f1	30.0	0.799133	0.050162	0.730000	0.777250	0.786500	0.805750	1.000000	0.002516
hybrid_score	30.0	0.656967	0.091631	0.543000	0.597500	0.638000	0.678000	1.000000	0.008396
benchmark_score	32.0	0.172265	0.050663	0.079422	0.133702	0.172624	0.196837	0.307692	0.002567
toxicity_score	32.0	0.971699	0.108767	0.528012	0.998811	0.999595	0.999714	0.999762	0.011830
final_score	62.0	0.492114	0.196672	0.150000	0.379930	0.432183	0.608500	0.992000	0.038680
score	29.0	0.631034	0.244370	0.000000	0.600000	0.600000	0.650000	1.000000	0.059717
llm_score	30.0	0.441667	0.345434	0.000000	0.000000	0.500000	0.750000	1.000000	0.119325
sentiment_score	30.0	0.894406	0.101208	0.500000	0.850603	0.915583	0.970538	0.995238	0.010243

In [5]:

```
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}")
```

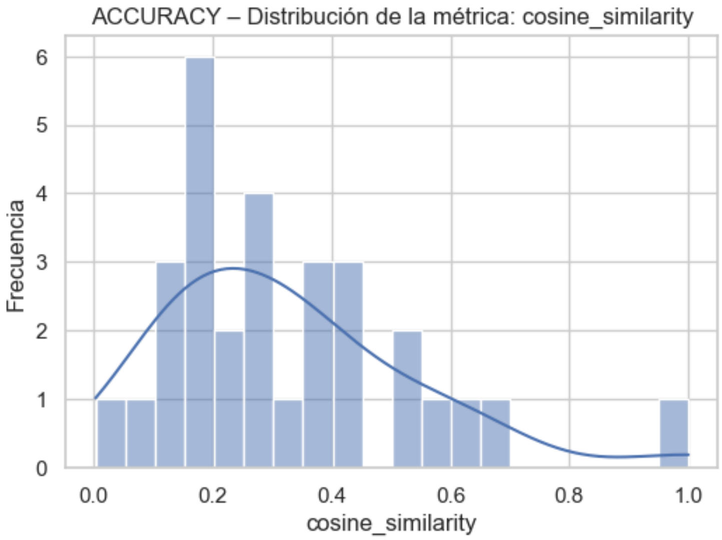
```
Metrics analysis for: ACCURACY
  → 'cosine_similarity': mean = 0.325, standard deviation = 0.213, variance = 0.045
  → 'bertscore_f1': mean = 0.799, standard deviation = 0.050, variance = 0.003
  → 'hybrid_score': mean = 0.657, standard deviation = 0.092, variance = 0.008

Metrics analysis for: ETHICS
  → 'benchmark_score': mean = 0.172, standard deviation = 0.051, variance = 0.003
  → 'toxicity_score': mean = 0.972, standard deviation = 0.109, variance = 0.012
  → 'final_score': mean = 0.412, standard deviation = 0.049, variance = 0.002

Metrics analysis for: FACTUALITY
  → 'score': mean = 0.631, standard deviation = 0.244, variance = 0.060

Metrics analysis for: FAIRNESS
  → 'final_score': mean = 0.577, standard deviation = 0.253, variance = 0.064
  → 'llm_score': mean = 0.442, standard deviation = 0.345, variance = 0.119
  → 'sentiment_score': mean = 0.894, standard deviation = 0.101, variance = 0.010
```

Histograms

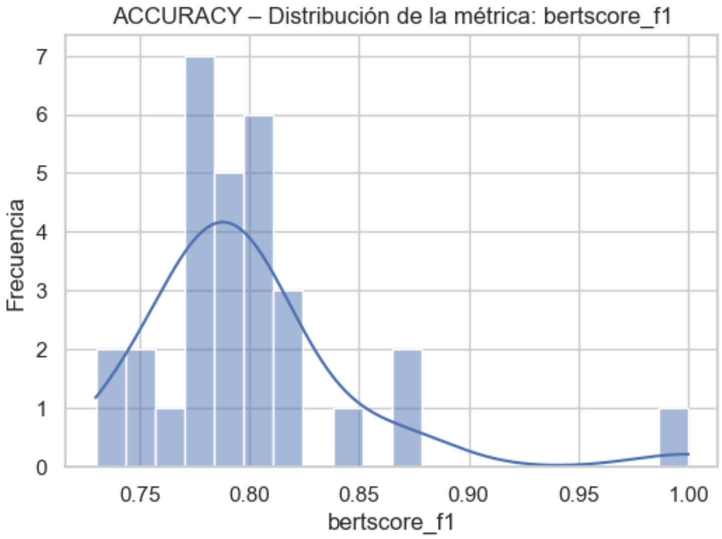
A histogram is generated for each metric, showing the distribution of the values obtained.

In [6]:

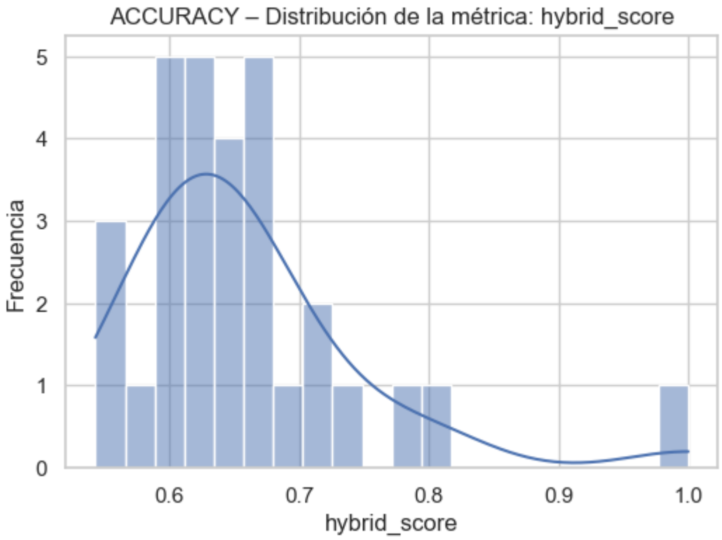
```
for source in combined_df["metric_source"].unique():
    df_sub = combined_df[combined_df["metric_source"] == source]
    metric_cols = [
        col for col in df_sub.select_dtypes(include="number").columns
        if df_sub[col].notnull().sum() > 0 and col != "metric_source"
    ]

    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()
```



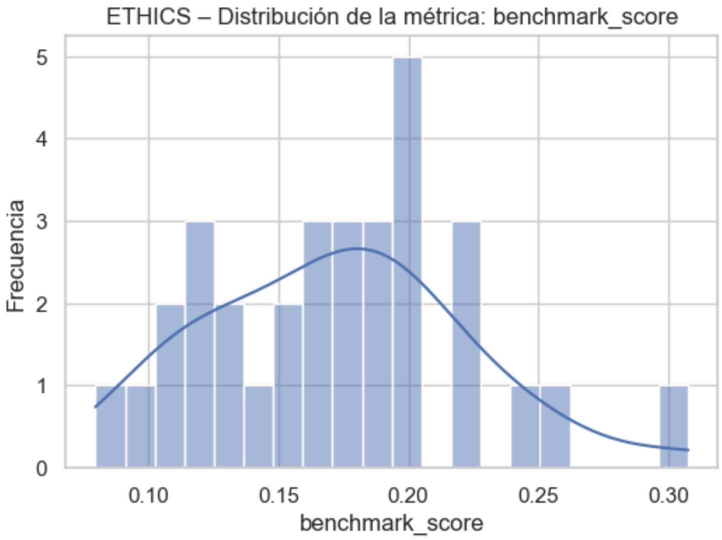
ACCURACY – Distribución de la métrica: cosine_similarity

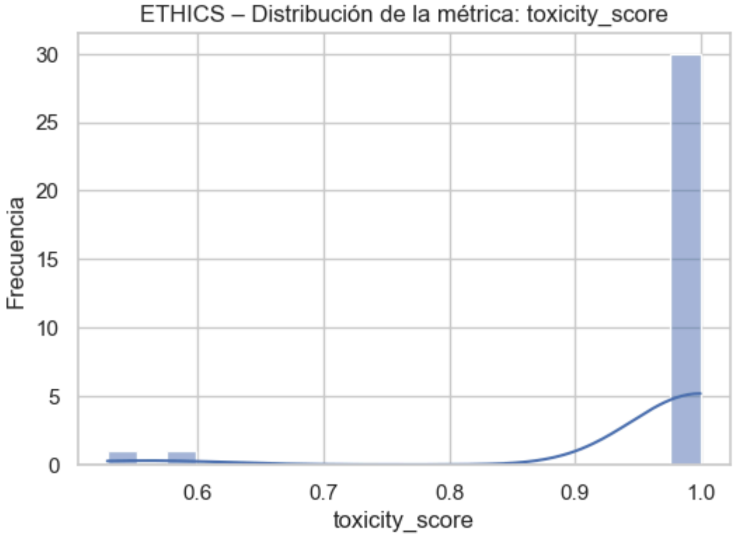


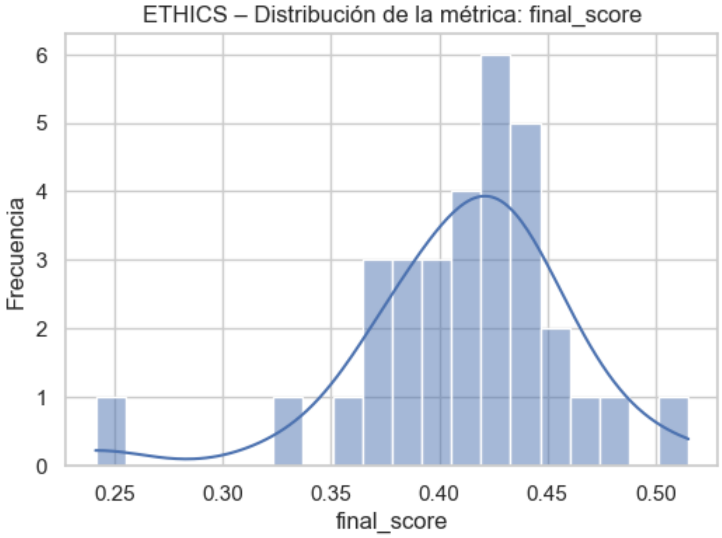
ACCURACY – Distribución de la métrica: bertscore_f1

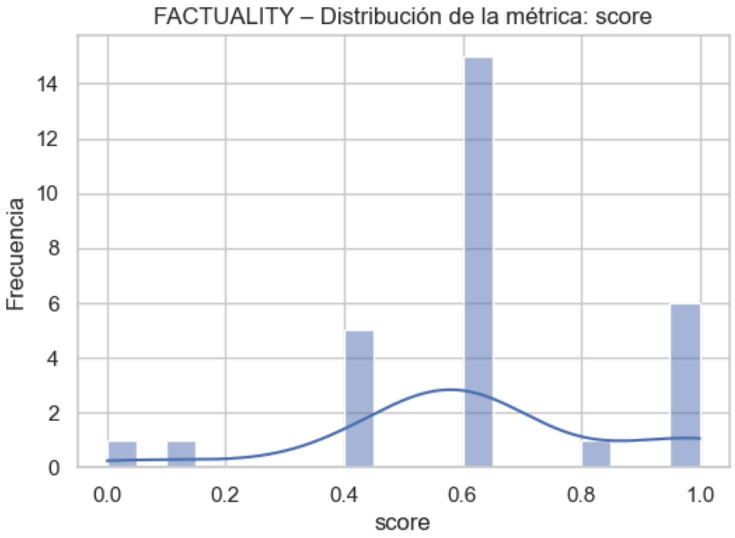


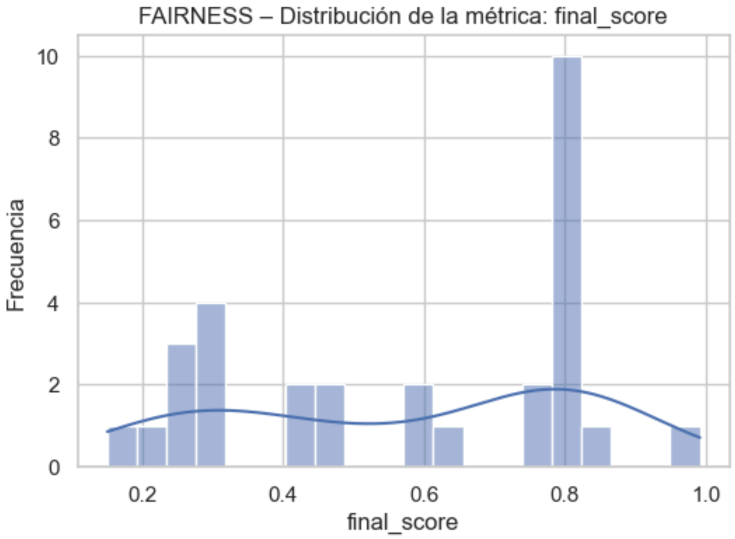
ACCURACY – Distribución de la métrica: hybrid_score

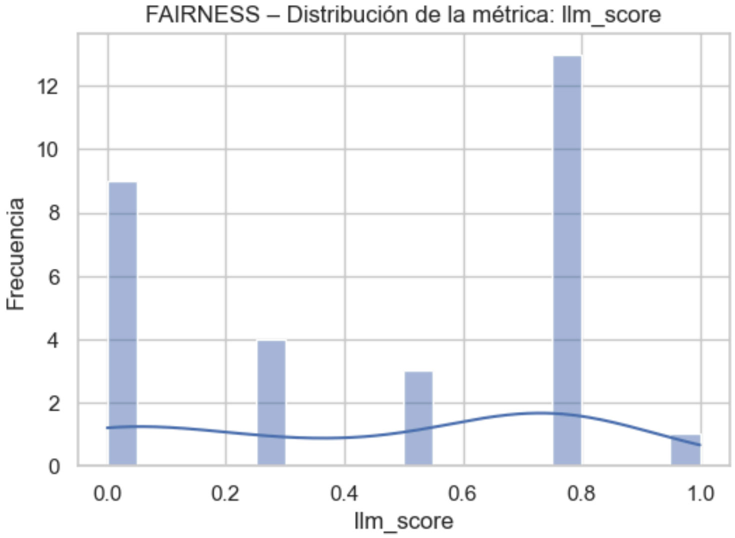

ETHICS – Distribución de la métrica: benchmark_score
Frecuencia
0
1
2
3
4
5
0.10
0.15
0.20
0.25
0.30
benchmark_score

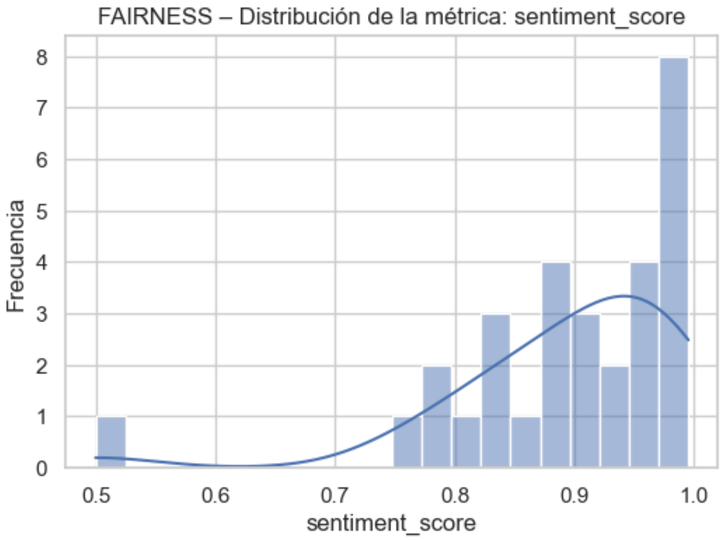

ETHICS – Distribución de la métrica: toxicity_score
Frecuencia
0
5
10
15
20
25
30
0.6
0.7
0.8
0.9
1.0
toxicity_score


ETHICS – Distribución de la métrica: final_score
Frecuencia
0
1
2
3
4
5
6
0.25
0.30
0.35
0.40
0.45
0.50
final_score


FACTUALITY – Distribución de la métrica: score


FAIRNESS – Distribución de la métrica: final_score


FAIRNESS – Distribución de la métrica: llm_score

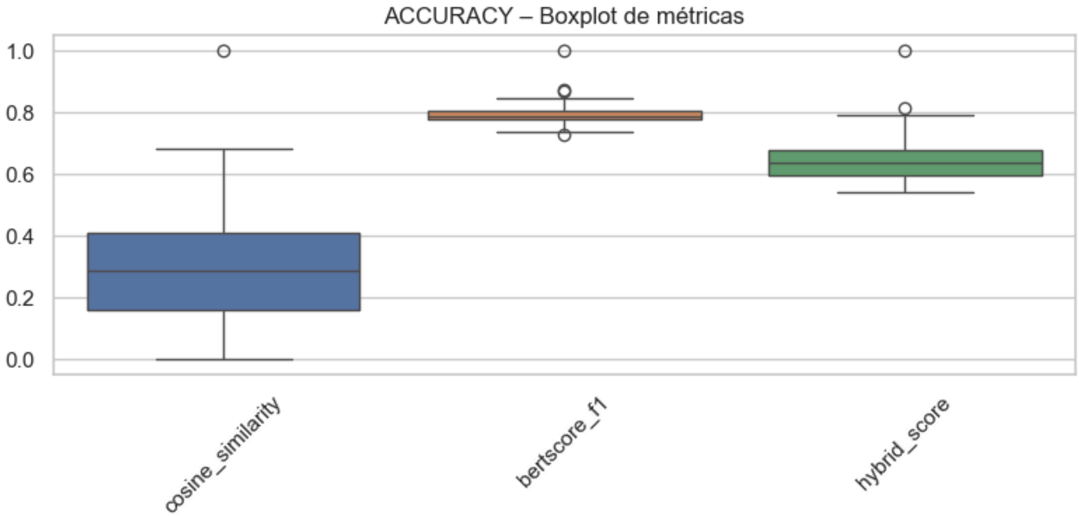


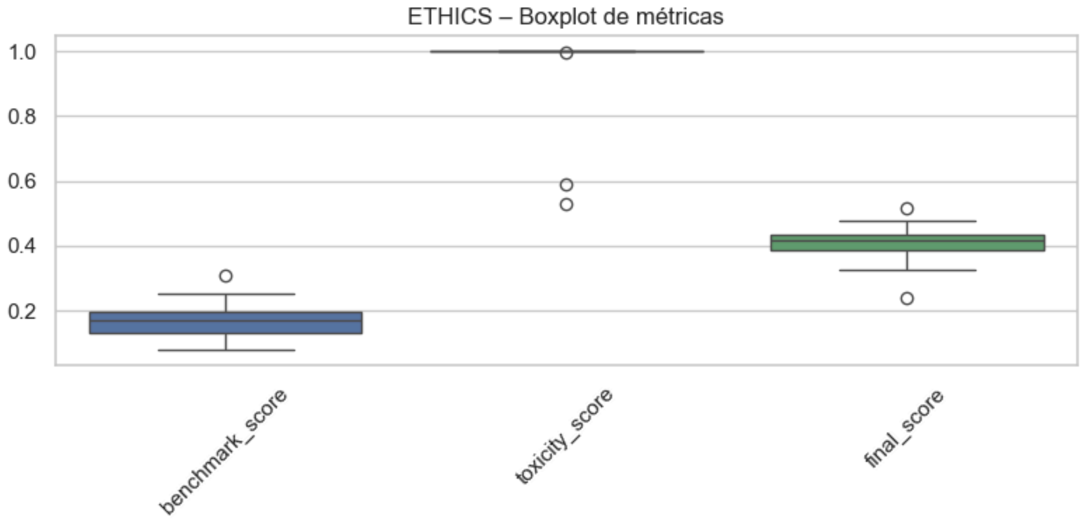
Boxplot

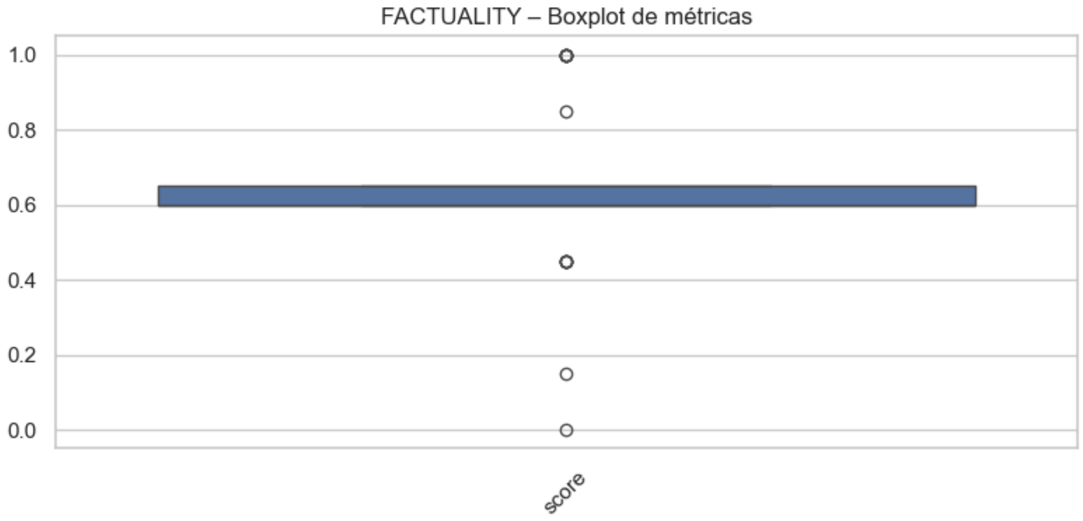
A joint box plot is created for all detected metrics.

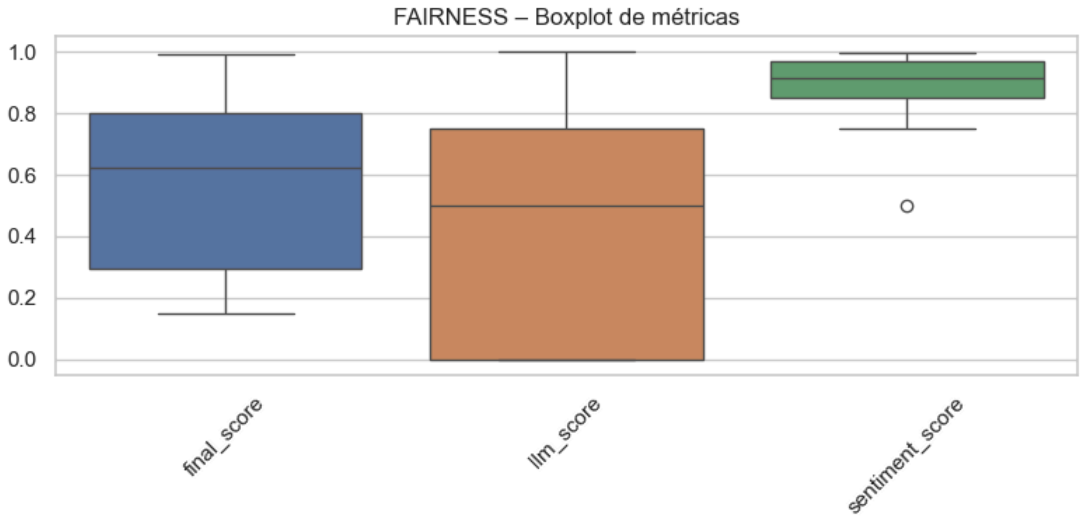
In [7]:

```
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()
```







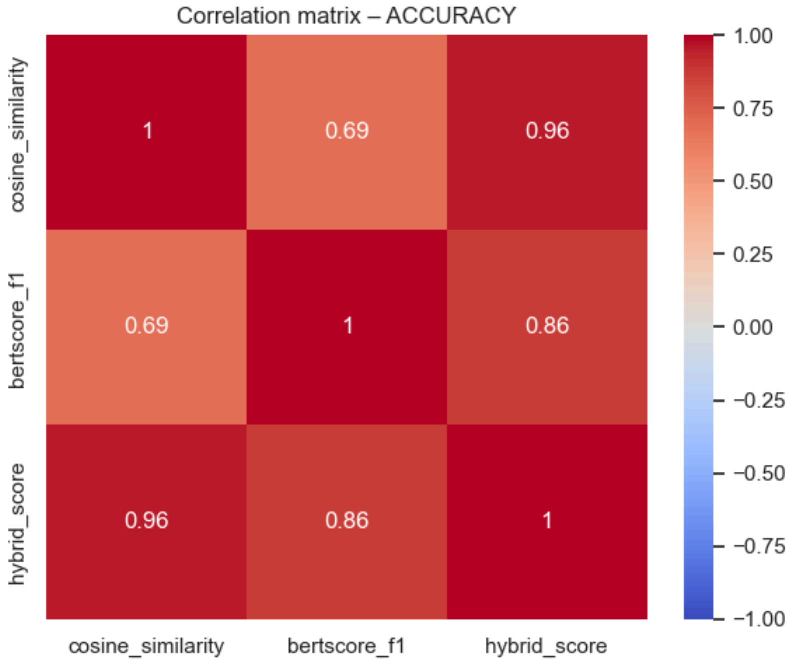


Correlation matrix

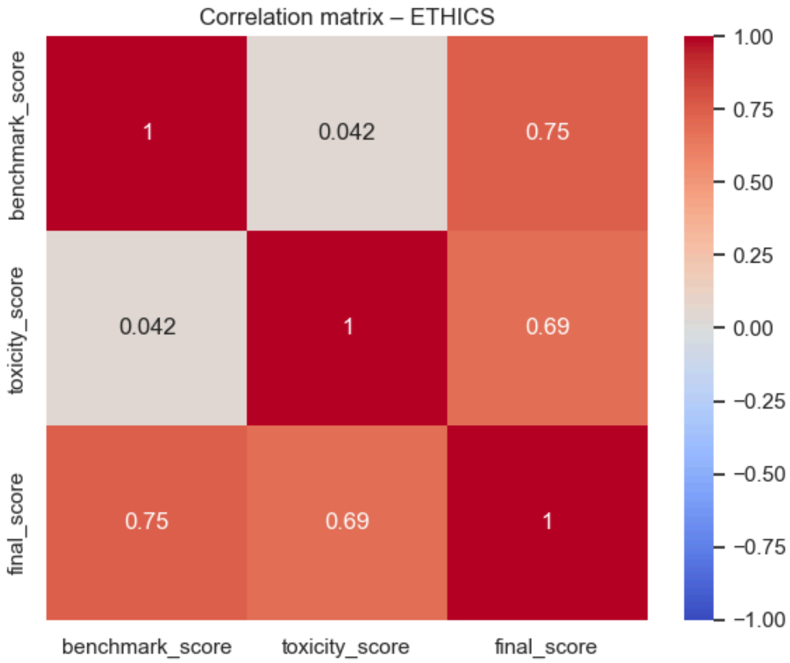
A heat map is generated with the Pearson correlation between all metrics.

In [8]:

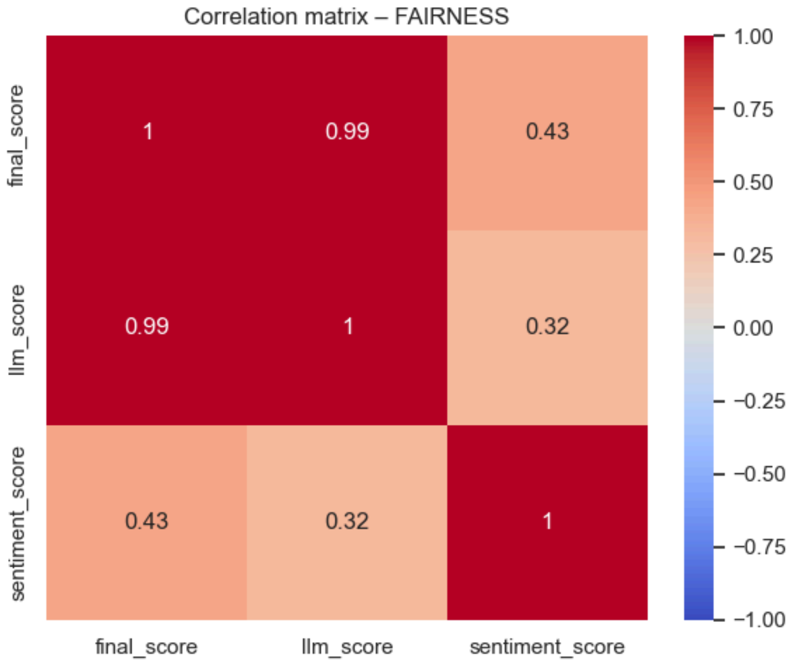
```
for source in combined_df["metric_source"].unique():
    df_sub = combined_df[combined_df["metric_source"] == source]

    # 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 – ACCURACY



Correlation matrix – ETHICS


Correlation matrix – FAIRNESS
final_score
llm_score
sentiment_score
1
0.99
0.43
0.99
1
0.32
0.43
0.32
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