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ProcessBigData25B / 00 - Challenge 3 / Challenge_3_HeartDisease_SparkML_v2 - PEREZ ROSAS LUIS ALFREDO.ipynb

DralFire Challenge 3 Avanzado c65cb05 · 3 minutes ago

855 lines (855 loc) · 194 KB

Challenge 3 Avanzado

Enfermedades Cardiovasculares ❤️

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Este challenge avanzado permitirá a los estudiantes aplicar PySpark para analizar grandes volúmenes de datos relacionados con un tema cercano a su investigación de tesis, integrando los conocimientos adquiridos en los challenges anteriores.

Utilizar APIs avanzadas como Spark Streaming o Spark ML para trabajar con una gran base de datos en tiempo real o construir un modelo predictivo complejo.

1) Parámetros de ejecución

Ajusta la ruta al CSV (usa `,` como separador por defecto). Si tu archivo tiene otra columna objetivo distinta a `target` o `num`, ajusta `LABEL_BASE_COL`.

In [2]:

```
# Parámetros
DATA_PATH = "data/heart_disease_uci.csv"  # <-- CAMBIA ESTA RUTA
CSV_SEP = ","                                 # separador común del CSV
OUTDIR = "outputs_heart"                       # carpeta de salida

# Si conoces la columna objetivo exacta, indícala aquí (por defecto intentará
LABEL_BASE_COL = None                          # e.g., "target" o "num"; si No

# %matplotlib inline  # Descomenta si estás en Jupyter clásico
```

2) Inicializar Spark

In [3]:

```
from pyspark.sql import SparkSession

spark = (
    SparkSession.builder
    .appName("challenge-3-avanzado-heart-v2")
    .getOrCreate()
)
spark
```

Out[3]: **SparkSession - in-memory**

SparkContext

Spark UI

Version	v3.5.7
Master	local[*]
AppName	challenge-3-avanzado-heart-v2

3) Carga de datos

In [4]:

```
from pyspark.sql import functions as F
import os

os.makedirs(OUTDIR, exist_ok=True)

raw = spark.read.csv(DATA_PATH, header=True, inferSchema=True, sep=CSV_SEP)
raw.printSchema()
raw.show(5)
```

```
root
 |-- id: integer (nullable = true)
 |-- age: integer (nullable = true)
 |-- sex: string (nullable = true)
 |-- dataset: string (nullable = true)
 |-- cp: string (nullable = true)
 |-- trestbps: integer (nullable = true)
 |-- chol: integer (nullable = true)
 |-- fbs: boolean (nullable = true)
 |-- restecg: string (nullable = true)
 |-- thalch: integer (nullable = true)
 |-- exang: boolean (nullable = true)
 |-- oldpeak: double (nullable = true)
 |-- slope: string (nullable = true)
 |-- ca: integer (nullable = true)
 |-- thal: string (nullable = true)
 |-- num: integer (nullable = true)

+---+---+------+---------+---------------+--------+----+-----+--------------+---
---+-----+-------+-----------+---+-----------------+---+
| id|age|   sex|  dataset|             cp|trestbps|chol|  fbs|       restecg|tha
lch|exang|oldpeak|      slope| ca|             thal|num|
+---+---+------+---------+---------------+--------+----+-----+--------------+---
---+-----+-------+-----------+---+-----------------+---+
|  1| 63|  Male|Cleveland| typical angina|     145| 233| true|lv hypertrophy|
150|false|    2.3|downsloping|  0|     fixed defect|  0|
|  2| 67|  Male|Cleveland|   asymptomatic|     160| 286|false|lv hypertrophy|
108| true|    1.5|       flat|  3|           normal|  2|
|  3| 67|  Male|Cleveland|   asymptomatic|     120| 229|false|lv hypertrophy|
129| true|    2.6|       flat|  2|reversable defect|  1|
|  4| 37|  Male|Cleveland|    non-anginal|     130| 250|false|        normal|
187|false|    3.5|downsloping|  0|           normal|  0|
|  5| 41|Female|Cleveland|atypical angina|     130| 204|false|lv hypertrophy|
172|false|    1.4|  upsloping|  0|           normal|  0|
+---+---+------+---------+---------------+--------+----+-----+--------------+---
---+-----+-------+-----------+---+-----------------+---+
only showing top 5 rows
```

Diccionario de Datos

id :: Identificador del paciente.

age :: Edad.

gender :: Género.

height :: Estatura.

weight :: Peso.

ap_hi :: Presión arterial sistólica

ap_lo :: Presión arterial diastólica

cholesterol :: Nivel de colesterol

gluc :: Nivel de glucosa:

smoke :: ¿Es fumador?

alco :: ¿Bebe alcohol?

active :: ¿Realiza actividad física?

cardio :: ¿Tiene alguna enfermedad cardiovascular diagnosticada?

4) Detección de la columna objetivo y creación de `label` binaria

In [5]:

```
# Detectar columna objetivo si no se especificó
candidates = [c for c in raw.columns if c.lower() in ("target", "num")]
base_col = LABEL_BASE_COL if LABEL_BASE_COL else (candidates[0] if candidates

if base_col is None:
    raise ValueError("No se pudo detectar la columna objetivo automáticamente.
                     "Indica LABEL_BASE_COL con el nombre correcto (p. ej., 't

print("Columna base para etiqueta:", base_col)

# Mapeo a binaria: label = 1 si valor > 0, 0 en otro caso
df = raw.withColumn("label", (F.col(base_col).cast("double") > F.lit(0.0)).cas
df.select(base_col, "label").groupBy("label").count().orderBy("label").show()
```

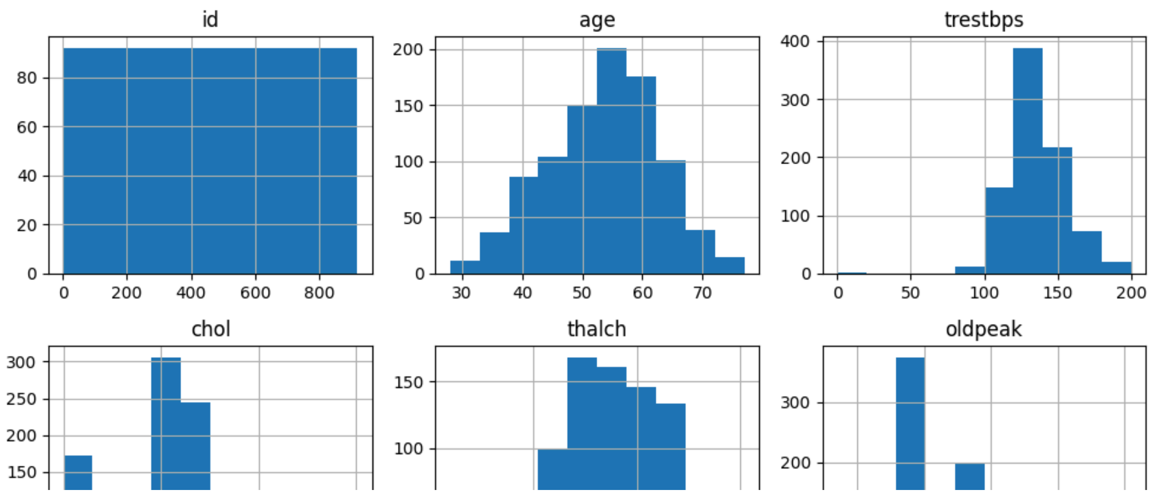
```
Columna base para etiqueta: num
+-----+-----+
|label|count|
+-----+-----+
|    0|  411|
|    1|  509|
+-----+-----+
```

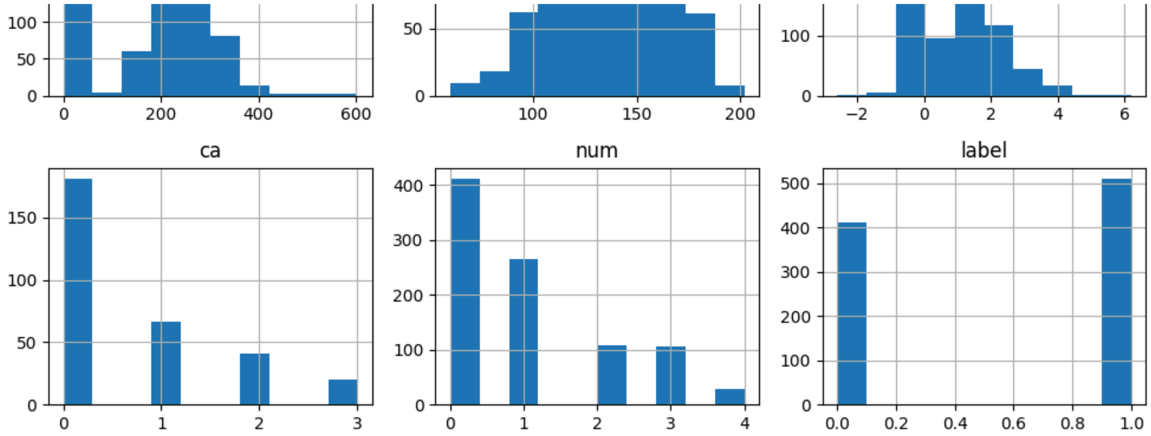
5) EDA con gráficas

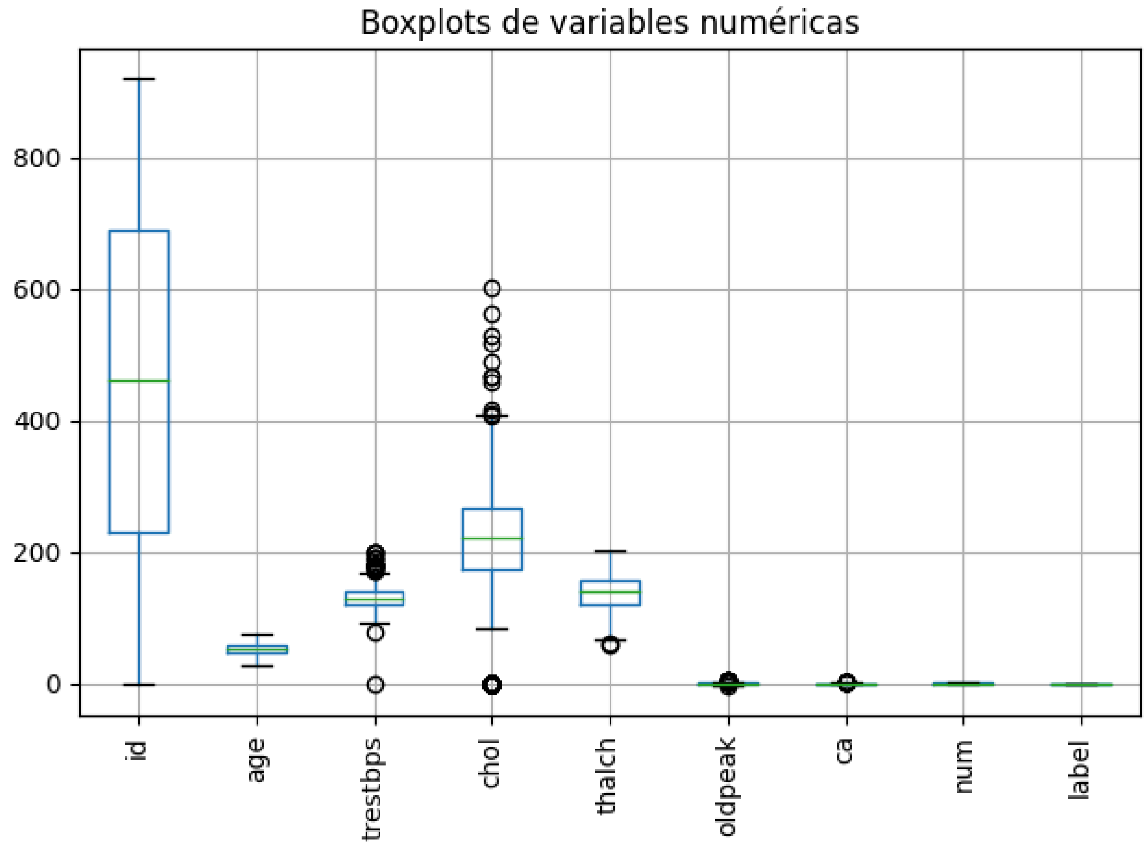
Importante: Usamos `matplotlib` (una figura por gráfico, sin estilos ni colores específicos).
Se convertirán los datos a pandas con `toPandas()` para graficar. Si el dataset es muy grande, considera muestrear (`sample()`).

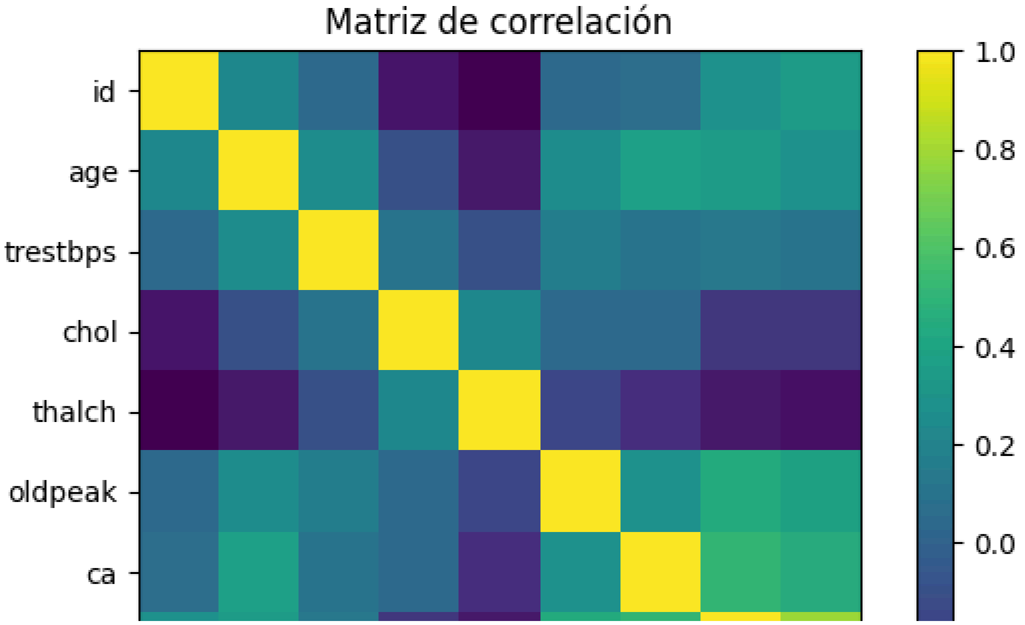
In [6]:

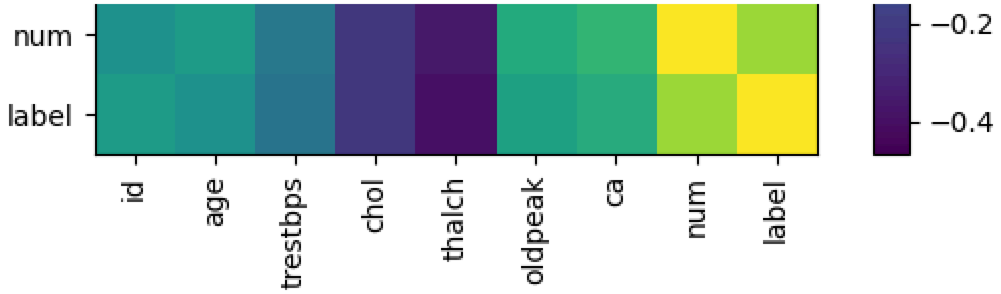
```
import matplotlib.pyplot as plt

# Seleccionar solo columnas numéricas para las gráficas
numeric_cols = [c for (c, t) in df.dtypes if t in ("int", "bigint", "double",
pdf = df.select(numeric_cols).toPandas()

# 5.1 Histogramas
ax = pdf.hist(figsize=(10, 8))
plt.tight_layout()
plt.savefig(os.path.join(OUTDIR, "histogramas.png"))
plt.show()

# 5.2 Boxplots
plt.figure()
pdf.boxplot(rot=90)
plt.title("Boxplots de variables numéricas")
plt.tight_layout()
plt.savefig(os.path.join(OUTDIR, "boxplots.png"))
plt.show()

# 5.3 Matriz de correlación
plt.figure()
corr = pdf.corr(numeric_only=True)
plt.imshow(corr, interpolation='nearest')
plt.xticks(range(len(corr.columns)), corr.columns, rotation=90)
plt.yticks(range(len(corr.columns)), corr.columns)
plt.colorbar()
plt.title("Matriz de correlación")
plt.tight_layout()
plt.savefig(os.path.join(OUTDIR, "correlacion.png"))
plt.show()

# 5.4 Distribución de la etiqueta
if "label" in df.columns:
    label_pdf = df.select("label").toPandas()
    plt.figure()
    label_pdf["label"].value_counts().sort_index().plot(kind="bar")
    plt.title("Distribución de la etiqueta")
    plt.xlabel("label")
    plt.ylabel("conteo")
    plt.tight_layout()
    plt.savefig(os.path.join(OUTDIR, "distribucion_label.png"))
    plt.show()
```

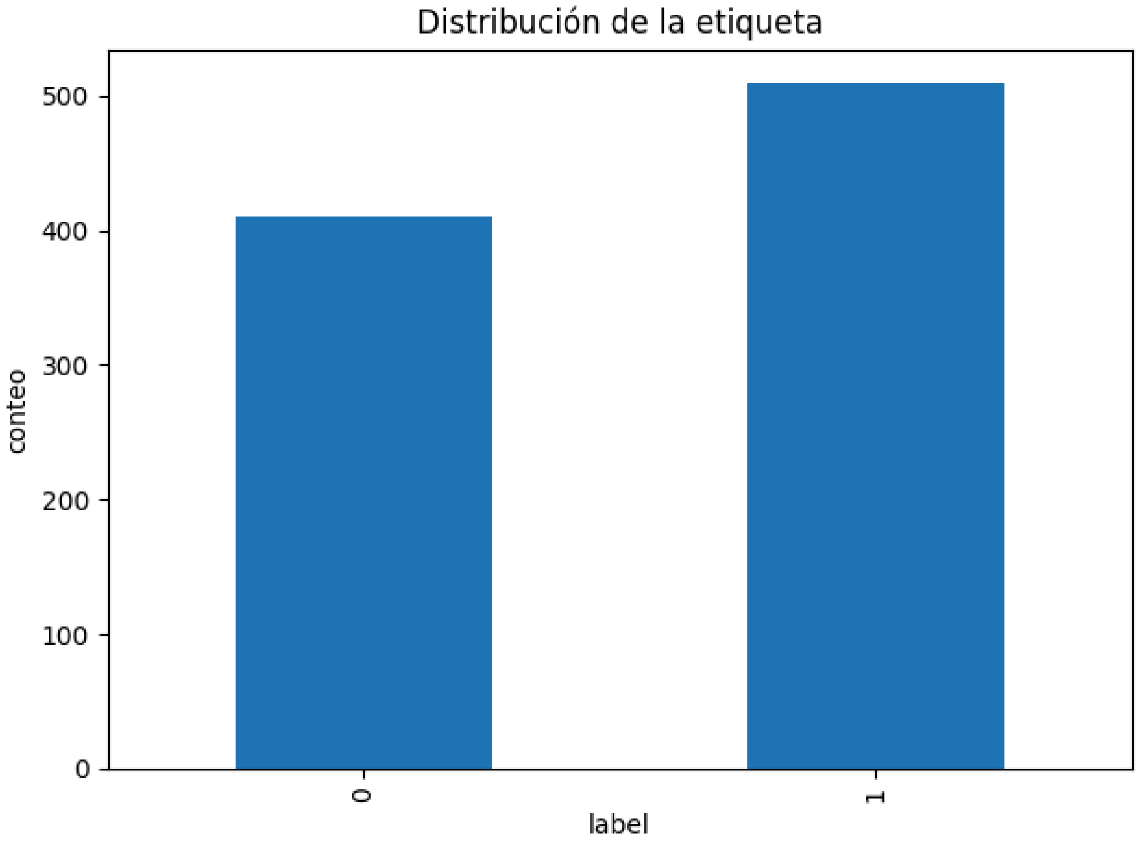



ca
num
label
0
50
100
150
0
1
2
3
0
100
200
300
400
0
1
2
3
4
0
100
200
300
400
500
0.0
0.2
0.4
0.6
0.8
1.0
0
50
100
0
200
400
600
50
0
100
150
200
100
0
−2
0
2
4
6


Boxplots de variables numéricas
0
200
400
600
800
id
age
trestbps
chol
thalch
oldpeak
ca
num
label


Matriz de correlación
id
age
trestbps
chol
thalch
oldpeak
ca
1.0
0.8
0.6
0.4
0.2
0.0





6) Preparación de datos y *features*

```
In [7]:
# Revisa tu esquema
df.printSchema()

# Columnas del ensamblador (ajusta si usaste otro nombre)
# Evita meter 'label' ni la columna objetivo original (target/num)
exclude = {"label", "target", "num", "features", "features_raw"}
feature_cols = [c for c, t in df.dtypes if c not in exclude]

# Qué columnas no son numéricas aún
non_numeric = [c for c, t in df.dtypes if c in feature_cols and t not in ("int
missing = [c for c in feature_cols if c not in dict(df.dtypes)]
print("No numéricas:", non_numeric)
print("Inexistentes:", missing)
```

```
root
 |-- id: integer (nullable = true)
 |-- age: integer (nullable = true)
 |-- sex: string (nullable = true)
 |-- sex: string (nullable = true)
 |-- dataset: string (nullable = true)
 |-- cp: string (nullable = true)
 |-- trestbps: integer (nullable = true)
 |-- chol: integer (nullable = true)
 |-- fbs: boolean (nullable = true)
 |-- restecg: string (nullable = true)
 |-- thalch: integer (nullable = true)
 |-- exang: boolean (nullable = true)
 |-- oldpeak: double (nullable = true)
 |-- slope: string (nullable = true)
 |-- ca: integer (nullable = true)
 |-- thal: string (nullable = true)
 |-- num: integer (nullable = true)
 |-- label: integer (nullable = true)

No numéricas: ['sex', 'dataset', 'cp', 'fbs', 'restecg', 'exang', 'slope', 'tha
l']
Inexistentes: []
```

In [24]:

```python
from pyspark.sql.functions import col, regexp_replace, trim
from pyspark.sql import functions as F

df_cast = df

# Elimina filas con nulos en cualquier columna
df_cast.na.drop()


for c in non_numeric:
    # Limpia espacios y comas decimales si las hubiera
    df_cast = df_cast.withColumn(c, trim(col(c)))
    df_cast = df_cast.withColumn(c, regexp_replace(col(c), ",", "."))  # por s
    df_cast = df_cast.withColumn(c, col(c).cast("double"))

# Recalcula solo columnas numéricas reales para el assembler
numeric_feature_cols = [
    c for c, t in df_cast.dtypes
    if c in feature_cols and t in ("int","bigint","double","float")
]
print("Usaré estas columnas numéricas:", numeric_feature_cols)

print(df_cast)
```

```
Usaré estas columnas numéricas: ['id', 'age', 'sex', 'dataset', 'cp', 'trestbp
s', 'chol', 'fbs', 'restecg', 'thalch', 'exang', 'oldpeak', 'slope', 'ca', 'tha
l']
DataFrame[id: int, age: int, sex: double, dataset: double, cp: double, trestbps:
int, chol: int, fbs: double, restecg: double, thalch: int, exang: double, oldpea
k: double, slope: double, ca: int, thal: double, num: int, label: int]
```

In [25]:

```python
from pyspark.ml.feature import VectorAssembler, StandardScaler
from pyspark.ml import Pipeline
```

In [26]:

```python
#
#assembler = VectorAssembler(
#    inputCols=numeric_feature_cols,
#    outputCol="features_raw",
#    outputCol="features_raw",
#    handleInvalid="skip"   # en Spark 3.5 soportado; salta filas con nulos/in
#)
#scaler = StandardScaler(inputCol="features_raw", outputCol="features")

#prep = Pipeline(stages=[assembler, scaler])

assembler = VectorAssembler(inputCols=numeric_feature_cols, outputCol="feature
scaler = StandardScaler(inputCol="features_raw", outputCol="features")
prep = Pipeline(stages=[assembler, scaler])


prepared = prep.fit(df_cast).transform(df_cast)

train, test = prepared.randomSplit([0.8, 0.2], seed=42)
train.count(), test.count()
```

Out[26]:

```
(771, 149)
```

In [ ]:

7) Modelado: Logistic Regression y Random Forest

In [40]:

```
from pyspark.ml.classification import LogisticRegression, RandomForestClassifi
from pyspark.ml.feature import Imputer

# Impute missing values in numeric features before modeling
imputer = Imputer(
        inputCols=numeric_feature_cols,
        outputCols=[f"{c}_imputed" for c in numeric_feature_cols]
).setStrategy("mean")

df_cast.na.drop()
df_cast.dropna()
df_cast.dropna(how='all')

df_imputed = imputer.fit(df_cast).transform(df_cast)

# Update assembler to use imputed columns
imputed_feature_cols = [f"{c}_imputed" for c in numeric_feature_cols]
assembler = VectorAssembler(inputCols=imputed_feature_cols, outputCol="feature
scaler = StandardScaler(inputCol="features_raw", outputCol="features")
prep = Pipeline(stages=[assembler, scaler])

prepared = prep.fit(df_imputed).transform(df_imputed)
train, test = prepared.randomSplit([0.8, 0.2], seed=42)

lr = LogisticRegression(featuresCol="features", labelCol="label")
rf = RandomForestClassifier(featuresCol="features", labelCol="label", numTrees

lr_model = lr.fit(train)
rf_model = rf.fit(train)

pred_lr = lr_model.transform(test)
```

```
pred_rf = rf_model.transform(test)

pred_lr.select("label", "prediction", "probability").show(5, truncate=False)
pred_rf.select("label", "prediction", "probability").show(5, truncate=False)
```

```
---------------------------------------------------------------------------
Py4JJavaError                             Traceback (most recent call last)
Cell In[40], line 14
     11 df_cast.dropna()
     12 df_cast.dropna(how='all')
---> 14 df_imputed = imputer.fit(df_cast).transform(df_cast)
     16 # Update assembler to use imputed columns
     17 imputed_feature_cols = [f"{c}_imputed" for c in numeric_feature_cols]

File c:\Users\alfre\anaconda3\envs\ProcessBigData25B\lib\site-packages\pyspark\m
l\base.py:205, in Estimator.fit(self, dataset, params)
    203         return self.copy(params)._fit(dataset)
    204     else:
--> 205         return self._fit(dataset)
    206 else:
    207     raise TypeError(
    208         "Params must be either a param map or a list/tuple of param map
s, "
    209         "but got %s." % type(params)
    210     )

File c:\Users\alfre\anaconda3\envs\ProcessBigData25B\lib\site-packages\pyspark\m
l\wrapper.py:381, in JavaEstimator._fit(self, dataset)
    380 def _fit(self, dataset: DataFrame) -> JM:
--> 381     java_model = self._fit_java(dataset)
    382     model = self._create_model(java_model)
    383     return self._copyValues(model)

File c:\Users\alfre\anaconda3\envs\ProcessBigData25B\lib\site-packages\pyspark\m
l\wrapper.py:378, in JavaEstimator._fit_java(self, dataset)
    375 assert self._java_obj is not None
    377 self._transfer_params_to_java()
--> 378 return self._java_obj.fit(dataset._jdf)

File c:\Users\alfre\anaconda3\envs\ProcessBigData25B\lib\site-packages\py4j\java
_gateway.py:1322, in JavaMember.__call__(self, *args)
   1316 command = proto.CALL_COMMAND_NAME +\
   1317     self.command_header +\
   1318     args_command +\
   1319     proto.END_COMMAND_PART
   1321 answer = self.gateway_client.send_command(command)
-> 1322 return_value = get_return_value(
   1323     answer, self.gateway_client, self.target_id, self.name)
   1325 for temp_arg in temp_args:
   1326     if hasattr(temp_arg, "_detach"):

File c:\Users\alfre\anaconda3\envs\ProcessBigData25B\lib\site-packages\pyspark\e
rrors\exceptions\captured.py:179, in capture_sql_exception.<locals>.deco(*a, **k
w)
    177 def deco(*a: Any, **kw: Any) -> Any:
    178     try:
--> 179         return f(*a, **kw)
    180     except Py4JJavaError as e:
    181         converted = convert_exception(e.java_exception)
```

```
File c:\Users\alfre\anaconda3\envs\ProcessBigData25B\lib\site-packages\py4j\prot
ocol.py:326, in get_return_value(answer, gateway_client, target_id, name)
    324 value = OUTPUT_CONVERTER[type](answer[2:], gateway_client)
    325 if answer[1] == REFERENCE_TYPE:
--> 326     raise Py4JJavaError(
    327         "An error occurred while calling {0}{1}{2}.\n".
    328         format(target_id, ".", name), value)
    329 else:
    330     raise Py4JError(
    331         "An error occurred while calling {0}{1}{2}. Trace:\n{3}\n".
    332         format(target_id, ".", name, value))

Py4JJavaError: An error occurred while calling o1244.fit.
: org.apache.spark.SparkException: surrogate cannot be computed. All the values
in sex,dataset,cp,fbs,restecg,exang,slope,thal are Null, Nan or missingValue(Na
N)
        at org.apache.spark.ml.feature.Imputer.fit(Imputer.scala:199)
        at java.base/jdk.internal.reflect.NativeMethodAccessorImpl.invoke0(Nativ
e Method)
        at java.base/jdk.internal.reflect.NativeMethodAccessorImpl.invoke(Native
MethodAccessorImpl.java:77)
        at java.base/jdk.internal.reflect.DelegatingMethodAccessorImpl.invoke(De
legatingMethodAccessorImpl.java:43)
        at java.base/java.lang.reflect.Method.invoke(Method.java:568)
        at py4j.reflection.MethodInvoker.invoke(MethodInvoker.java:244)
        at py4j.reflection.ReflectionEngine.invoke(ReflectionEngine.java:374)
        at py4j.Gateway.invoke(Gateway.java:282)
        at py4j.commands.AbstractCommand.invokeMethod(AbstractCommand.java:132)
        at py4j.commands.CallCommand.execute(CallCommand.java:79)
        at py4j.ClientServerConnection.waitForCommands(ClientServerConnection.ja
va:182)
        at py4j.ClientServerConnection.run(ClientServerConnection.java:106)
        at java.base/java.lang.Thread.run(Thread.java:842)
```

8) Evaluación (AUC)

In [32]:

```
from pyspark.ml.evaluation import BinaryClassificationEvaluator

evaluator = BinaryClassificationEvaluator(labelCol="label", rawPredictionCol="
auc_lr = evaluator.evaluate(pred_lr)
auc_rf = evaluator.evaluate(pred_rf)

print("AUC LR:", auc_lr)
print("AUC RF:", auc_rf)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[32], line 4
      1 from pyspark.ml.evaluation import BinaryClassificationEvaluator
      3 evaluator = BinaryClassificationEvaluator(labelCol="label", rawPredictio
nCol="rawPrediction")
----> 4 auc_lr = evaluator.evaluate(pred_lr)
      5 auc_rf = evaluator.evaluate(pred_rf)
      7 print("AUC LR:", auc_lr)

NameError: name 'pred_lr' is not defined
```

9) Curvas ROC y PR (LR, training summary)

In [33]:

```
# Curvas obtenidas del summary de entrenamiento de LR
try:
    train_summary = lr_model.summary

    # ROC
    roc_df = train_summary.roc.toPandas()
    plt.figure()
    plt.plot(roc_df['FPR'], roc_df['TPR'])
    plt.xlabel('FPR')
    plt.ylabel('TPR')
    plt.title('Curva ROC (LR, training)')
    plt.tight_layout()
    plt.savefig(os.path.join(OUTDIR, "roc_lr_training.png"))
    plt.show()

    # PR
    pr_df = train_summary.pr.toPandas()
    plt.figure()
    plt.plot(pr_df['recall'], pr_df['precision'])
    plt.xlabel('Recall')
    plt.ylabel('Precision')
    plt.title('Curva Precision-Recall (LR, training)')
    plt.tight_layout()
    plt.savefig(os.path.join(OUTDIR, "pr_lr_training.png"))
    plt.show()
except Exception as e:
    print("[WARN] No se pudieron generar curvas LR:", e)
```

```
[WARN] No se pudieron generar curvas LR: name 'lr_model' is not defined
```

10) Matrices de confusión (Spark puro)

In [34]:

```
import numpy as np

def confusion_matrix_spark(pred_df):
    cm_pdf = (
        pred_df.groupBy("label", "prediction")
        .count()
        .toPandas()
    )
    labels = sorted(set(cm_pdf["label"]).union(set(cm_pdf["prediction"])))
    size = len(labels)
    mat = [[0 for _ in range(size)] for _ in range(size)]
    for _, row in cm_pdf.iterrows():
        i = labels.index(row["label"])
        j = labels.index(row["prediction"])
        mat[i][j] = int(row["count"])
    return np.array(mat), labels
```

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Preview Code Blame Raw

```python
plt.ylabel("Real")
for i in range(cm_rf.shape[0]):
    for j in range(cm_rf.shape[1]):
        plt.text(j, i, int(cm_rf[i, j]), ha="center", va="center")
plt.colorbar()
plt.tight_layout()
plt.savefig(os.path.join(OUTDIR, "confusion_rf.png"))
plt.show()

cm_lr, labels_lr = confusion_matrix_spark(pred_lr)
plt.figure()
plt.imshow(cm_lr, interpolation="nearest")
plt.title("Matriz de confusión (LR)")
plt.xlabel("Predicho")
plt.ylabel("Real")
for i in range(cm_lr.shape[0]):
    for j in range(cm_lr.shape[1]):
        plt.text(j, i, int(cm_lr[i, j]), ha="center", va="center")
plt.colorbar()
plt.tight_layout()
plt.savefig(os.path.join(OUTDIR, "confusion_lr.png"))
plt.show()
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[34], line 18
     15         mat[i][j] = int(row["count"])
     16     return np.array(mat), labels
---> 18 cm_rf, labels_rf = confusion_matrix_spark(pred_rf)
     19 plt.figure()
     20 plt.imshow(cm_rf, interpolation="nearest")

NameError: name 'pred_rf' is not defined
```

11) Importancia de variables (RF)

In [35]:

```python
import pandas as pd

fi = pd.DataFrame({
    "feature": feature_cols,
    "importance": rf_model.featureImportances.toArray()
}).sort_values("importance", ascending=False)

fi.head(15)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[35], line 5
      1 import pandas as pd
      3 fi = pd.DataFrame({
      4     "feature": feature_cols,
----> 5     "importance": rf_model.featureImportances.toArray()
      6 }).sort_values("importance", ascending=False)
      8 fi.head(15)

NameError: name 'rf_model' is not defined
```

In [15]:

```
# Gráfico de importancia
plt.figure()
plt.bar(fi["feature"], fi["importance"])
plt.xticks(rotation=90)
plt.title("Importancia de variables (RF) — Heart Disease")
plt.tight_layout()
plt.savefig(os.path.join(OUTDIR, "feature_importance_rf.png"))
plt.show()

fi.to_csv(os.path.join(OUTDIR, "feature_importance_rf.csv"), index=False)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[15], line 3
      1 # Gráfico de importancia
      2 plt.figure()
----> 3 plt.bar(fi["feature"], fi["importance"])
      4 plt.xticks(rotation=90)
      5 plt.title("Importancia de variables (RF) — Heart Disease")

NameError: name 'fi' is not defined
<Figure size 640x480 with 0 Axes>
```

12) Conclusiones