```
# Paso 1: Instalar librerías del proyecto
!pip -q install --upgrade pip
!pip -q install yfinance pandas numpy matplotlib seaborn statsmodels pandas-datareader scikit-learn
!pip install PyPortfolioOpt
```

```
Requirement already satisfied: PyPortfolioOpt in /usr/local/lib/python3.12/dist-packages (1.5.6)
Requirement already satisfied: cvxpy>=1.1.19 in /usr/local/lib/python3.12/dist-packages (from PyPortfolioOpt) (1.
Requirement already satisfied: ecos<3.0.0,>=2.0.14 in /usr/local/lib/python3.12/dist-packages (from PyPortfolioOp
Requirement already satisfied: numpy>=1.26.0 in /usr/local/lib/python3.12/dist-packages (from PyPortfolioOpt) (2.
Requirement already satisfied: pandas>=0.19 in /usr/local/lib/python3.12/dist-packages (from PyPortfolioOpt) (2.2
Requirement already satisfied: plotly<6.0.0,>=5.0.0 in /usr/local/lib/python3.12/dist-packages (from PyPortfolioO
Requirement already satisfied: scipy>=1.3 in /usr/local/lib/python3.12/dist-packages (from PyPortfolioOpt) (1.16.
Requirement already satisfied: tenacity>=6.2.0 in /usr/local/lib/python3.12/dist-packages (from plotly<6.0.0,>=5.
Requirement already satisfied: packaging in /usr/local/lib/python3.12/dist-packages (from plotly<6.0.0,>=5.0.0->P
Requirement already satisfied: osqp>=0.6.2 in /usr/local/lib/python3.12/dist-packages (from cvxpy>=1.1.19->PyPort
Requirement already satisfied: clarabel>=0.5.0 in /usr/local/lib/python3.12/dist-packages (from cvxpy>=1.1.19->Py
Requirement already satisfied: scs>=3.2.4.post1 in /usr/local/lib/python3.12/dist-packages (from cvxpy>=1.1.19->P
Requirement already satisfied: cffi in /usr/local/lib/python3.12/dist-packages (from clarabel>=0.5.0->cvxpy>=1.1.
Requirement already satisfied: jinja2 in /usr/local/lib/python3.12/dist-packages (from osqp>=0.6.2->cvxpy>=1.1.19
Requirement already satisfied: setuptools in /usr/local/lib/python3.12/dist-packages (from osqp>=0.6.2->cvxpy>=1.
Requirement already satisfied: joblib in /usr/local/lib/python3.12/dist-packages (from osqp>=0.6.2->cvxpy>=1.1.19
Requirement already satisfied: python-dateutil>=2.8.2 in /usr/local/lib/python3.12/dist-packages (from pandas>=0.
Requirement already satisfied: pytz>=2020.1 in /usr/local/lib/python3.12/dist-packages (from pandas>=0.19->PyPort
Requirement already satisfied: tzdata>=2022.7 in /usr/local/lib/python3.12/dist-packages (from pandas>=0.19->PyPo
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.12/dist-packages (from python-dateutil>=2.8.2->
Requirement already satisfied: pycparser in /usr/local/lib/python3.12/dist-packages (from cffi->clarabel>=0.5.0->
Requirement already satisfied: MarkupSafe>=2.0 in /usr/local/lib/python3.12/dist-packages (from jinja2->osqp>=0.6
```

```
# Paso 2: Importar librerías y chequear versiones

import sys, platform, warnings, datetime as dt
import numpy as np
import pandas as pd
import yfinance as yf
import matplotlib as mpl
import matplotlib.pyplot as plt
import seaborn as sns
import statsmodels.api as sm
import pandas_datareader.data as web
import os, datetime as dt
import math


from pypfopt import EfficientFrontier, risk_models, expected_returns, DiscreteAllocation

warnings.filterwarnings("ignore")

# Mostrar versiones
print("Python:", sys.version.split()[0])
print("OS:", platform.platform())
print("pandas:", pd.__version__)
print("numpy:", np.__version__)
print("matplotlib:", mpl.__version__)
print("seaborn:", sns.__version__)
print("yfinance:", yf.__version__)
print("statsmodels:", sm.__version__)

# Configuración de gráficos
plt.rcParams["figure.figsize"] = (10, 5)
plt.rcParams["axes.grid"] = True

# Fechas del proyecto
START_DATE = "2022-01-01"
END_DATE   = dt.date.today().strftime("%Y-%m-%d")
print("Rango de análisis:", START_DATE, "→", END_DATE)

# Semilla para reproducibilidad
np.random.seed(42)

# Definir tickers
CEDEARS_BA = [
    "AAPL.BA","MSFT.BA","NVDA.BA","AMZN.BA","TSLA.BA","DIS.BA","GOOGL.BA",
    "MELI.BA","BRK.BA","KO.BA","JNJ.BA","PG.BA","PFE.BA","NKE.BA",
    "GLD.BA","EEM.BA","IEUR.BA","YPF.BA","PAMP.BA","VIST.BA"
]
CRYPTO = ["BTC-USD"]
BENCH  = ["SPY"]

print("CEDEARs:", len(CEDEARS_BA), "Crypto:", CRYPTO, "Benchmark:", BENCH)
```

```
Python: 3.12.12
OS: Linux-6.6.105+-x86_64-with-glibc2.35
pandas: 2.2.2
numpy: 2.0.2
matplotlib: 3.10.0
seaborn: 0.13.2
yfinance: 0.2.66
statsmodels: 0.14.5
Rango de análisis: 2022-01-01 → 2025-11-30
CEDEARs: 20 Crypto: ['BTC-USD'] Benchmark: ['SPY']
```

```
# Paso 3: Montar Google Drive y definir rutas del proyecto

from google.colab import drive
drive.mount('/content/drive', force_remount=True)

import os

# Nombre exacto de tu carpeta en Drive
BASE_DIR = "/content/drive/MyDrive/Colab Notebooks/Proyecto Python Cartera Gino"

# Subcarpetas para organizar
DATA_DIR = os.path.join(BASE_DIR, "data")
FIGS_DIR = os.path.join(BASE_DIR, "figs")
os.makedirs(DATA_DIR, exist_ok=True)
os.makedirs(FIGS_DIR, exist_ok=True)

print("Carpeta base:", BASE_DIR)
print("Carpeta data:", DATA_DIR)
```

```
print("Carpeta figs:", FIGS_DIR)
```

```
Mounted at /content/drive
Carpeta base: /content/drive/MyDrive/Colab Notebooks/Proyecto Python Cartera Gino
Carpeta data: /content/drive/MyDrive/Colab Notebooks/Proyecto Python Cartera Gino/data
Carpeta figs: /content/drive/MyDrive/Colab Notebooks/Proyecto Python Cartera Gino/figs
```

```
# Paso 4: Definir tickers y mostrar tabla (sin SPY)

tickers = [
    "AAPL","MSFT","NVDA","AMZN","TSLA","DIS","GOOGL",
    "MELI","BRK-B","KO","JNJ","PG","PFE","NKE",
    "GLD","EEM","IEUR","YPF","PAM","VIST",
    "UNH",
    "BTC-USD","SPY"
]

# Excluir SPY
tickers_sin_spy = [t for t in tickers if t != "SPY"]

# Ordenar
tickers_sorted = sorted(tickers_sin_spy)

# Crear DataFrame
df_tickers = pd.DataFrame({"Ticker": tickers_sorted})
df_tickers.index = df_tickers.index + 1
df_tickers.index.name = "N°"

# Mostrar con estilo oscuro
display(
    df_tickers.style
    .set_caption("Listado de Tickers del Portafolio (Orden Alfabético, sin SPY)")
    .set_table_styles([
        {"selector": "th", "props": [
            ("background-color", "#1E1E1E"),
            ("color", "white"),
            ("padding", "6px 10px"),
            ("font-size", "12px"),
            ("border", "1px solid #444"),
            ("text-align", "center")
        ]},
        {"selector": "td", "props": [
            ("background-color", "#2B2B2B"),
            ("color", "#E0E0E0"),
            ("padding", "6px 10px"),
            ("font-size", "12px"),
            ("border", "1px solid #444"),
            ("text-align", "center")
        ]},
        {"selector": "caption", "props": [
            ("caption-side", "top"),
            ("font-size", "14px"),
            ("font-weight", "bold"),
            ("color", "#E0E0E0"),
            ("text-align", "center"),
            ("padding", "6px")
        ]}
    ])
)
```

Listado de Tickers del Portafolio (Orden Alfabético, sin SPY)

	Ticker
N°	
1	AAPL
2	AMZN
3	BRK-B
4	BTC-USD
5	DIS
6	EEM
7	GLD
8	GOOGL
9	IEUR
10	JNJ
11	KO
12	MELI
13	MSFT
14	NKE
15	NVDA
16	PAM
17	PFE
18	PG
19	TSLA
20	UNH
21	VIST
22	YPF

```
# Paso 5: Descargar precios ajustados (2022 → hoy)

raw = yf.download(
    tickers,
    start="2022-01-01",
    end=dt.date.today().strftime("%Y-%m-%d"),
    auto_adjust=True,
    progress=False
)

# Selección de precios de cierre
if isinstance(raw.columns, pd.MultiIndex):
    data = raw.xs('Close', level=0, axis=1).copy()
else:
    data = raw['Close'].copy()

# Eliminación de filas con faltantes
data = data.dropna()

# Vista rápida
print("Dimensiones:", data.shape)
data.head()
```

```
Dimensiones: (981, 23)
```

Ticker	AAPL	AMZN	BRK-B	BTC-USD	DIS	EEM	GLD	GOOGL	IEUR	JNJ
Date										
2022-01-03	178.270340	170.404495	300.790009	46458.117188	154.189529	45.263573	168.330002	143.998322	52.333141	152.576859
2022-01-04	176.007782	167.522003	308.529999	45897.574219	153.176422	45.107178	169.570007	143.410385	52.449081	152.167725
2022-01-05	171.326019	164.356995	309.920013	43569.003906	152.645294	44.371185	169.059998	136.831268	52.012081	153.181717
2022-01-06	168.466019	163.253998	313.220001	43160.929688	154.327240	44.573582	166.990005	136.803955	51.798042	152.656937
2022-01-07	168.632492	162.554001	319.779999	41557.902344	155.242004	44.978378	167.750000	136.078461	52.074509	154.720444

5 rows × 23 columns

```
import matplotlib.pyplot as plt
plt.style.use("dark_background")
```

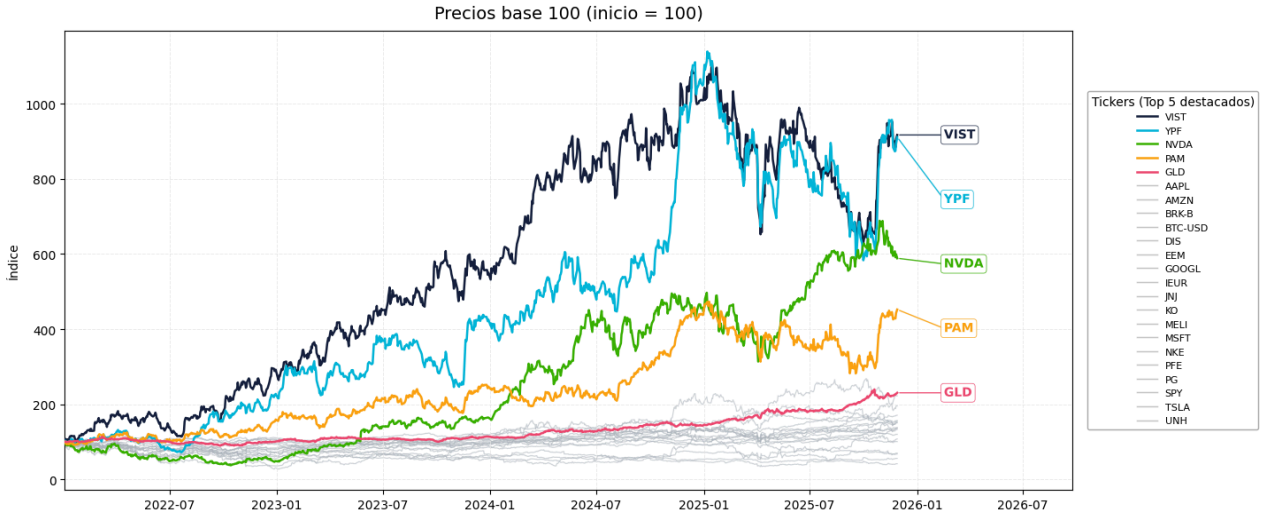
```
# Paso 6: Precios base 100
from matplotlib import patheffects as pe
from cycler import cycler

# Cálculo base 100
base100 = data.div(data.iloc[0]).mul(100)

print("Dimensiones base100:", base100.shape)
display(base100.head())

# Últimos valores y top 5
last_values = base100.iloc[-1].sort_values(ascending=False)
top_tickers = last_values.head(5).index.tolist()

# Gráfico
with plt.style.context('default'):
    fig, ax = plt.subplots(figsize=(17, 6))
    ax.set_facecolor("white")
    fig.patch.set_facecolor("white")

    # Líneas grises para los no destacados
    ax.plot(base100.index, base100.values, color="#adb5bd",
            linewidth=0.8, alpha=0.6, zorder=1)

    # Colores para los top 5 (dinámicos, sin hardcodear tickers)
    paleta_top5 = ["#14213d", "#00b4d8", "#38b000", "#fca311", "#ef476f"]
    color_map = dict(zip(top_tickers, paleta_top5))

    # Top 5 destacados
    for t in top_tickers:
        ax.plot(base100.index, base100[t],
                color=color_map.get(t, "#333333"),
                linewidth=1.8, zorder=3, label=t)

    # Coordenadas para etiquetas
    y_last = {t: float(base100[t].iloc[-1]) for t in top_tickers}
    ordered = sorted(top_tickers, key=lambda k: y_last[k])
    ymin, ymax = ax.get_ylim()
    pad = (ymax - ymin) * 0.05
    y_targets = np.linspace(
        max(ymin + pad, min(y_last.values())),
        min(ymax - pad, max(y_last.values())),
        num=len(ordered)
    )
    last_x = base100.index[-1]
    x_text = last_x + pd.Timedelta(days=80)

    # Etiquetas de color con líneas guía
    for t, y_tgt in zip(ordered, y_targets):
        c = color_map.get(t, "#000000")
        ax.annotate(
            "",
            xy=(x_text, y_tgt),
            xytext=(last_x, y_last[t]),
            arrowprops=dict(arrowstyle="-", color=c, lw=1, alpha=0.9),
            zorder=4
```

```
        )
        ax.text(
            x_text, y_tgt, f"{t}",
            va="center", ha="left",
            fontsize=10, color=c, fontweight="bold",
            bbox=dict(boxstyle="round,pad=0.25",
                      fc="white", ec=c, lw=0.5, alpha=0.95),
            path_effects=[pe.withStroke(linewidth=1, foreground="white")],
            zorder=5
        )

    # Ejes y estilo general
    ax.set_title("Precios base 100 (inicio = 100)",
                 fontsize=14, color="black", pad=10)
    ax.set_ylabel("Índice", color="black")
    ax.tick_params(colors="black")
    ax.spines["bottom"].set_color("black")
    ax.spines["left"].set_color("black")
    ax.grid(True, color="#e6e6e6", linestyle="--",
            linewidth=0.7, alpha=0.8)
    ax.set_xlim(base100.index[0],
                base100.index[-1] + pd.Timedelta(days=300))

    # Leyenda lateral
    handles, labels = ax.get_legend_handles_labels()
    otros_tickers = [t for t in base100.columns if t not in top_tickers]
    for t in otros_tickers:
        h, = ax.plot([], [], color="#c7c7c7", lw=1, label=t)
        handles.append(h)
        labels.append(t)

    leg = ax.legend(
        handles, labels,
        title="Tickers (Top 5 destacados)",
        frameon=True, facecolor="white", edgecolor="#999",
        fontsize=8, ncol=1,
        loc='center left', bbox_to_anchor=(1.01, 0.5)
    )

    plt.tight_layout(rect=[0, 0, 0.85, 1])
    plt.show()
```

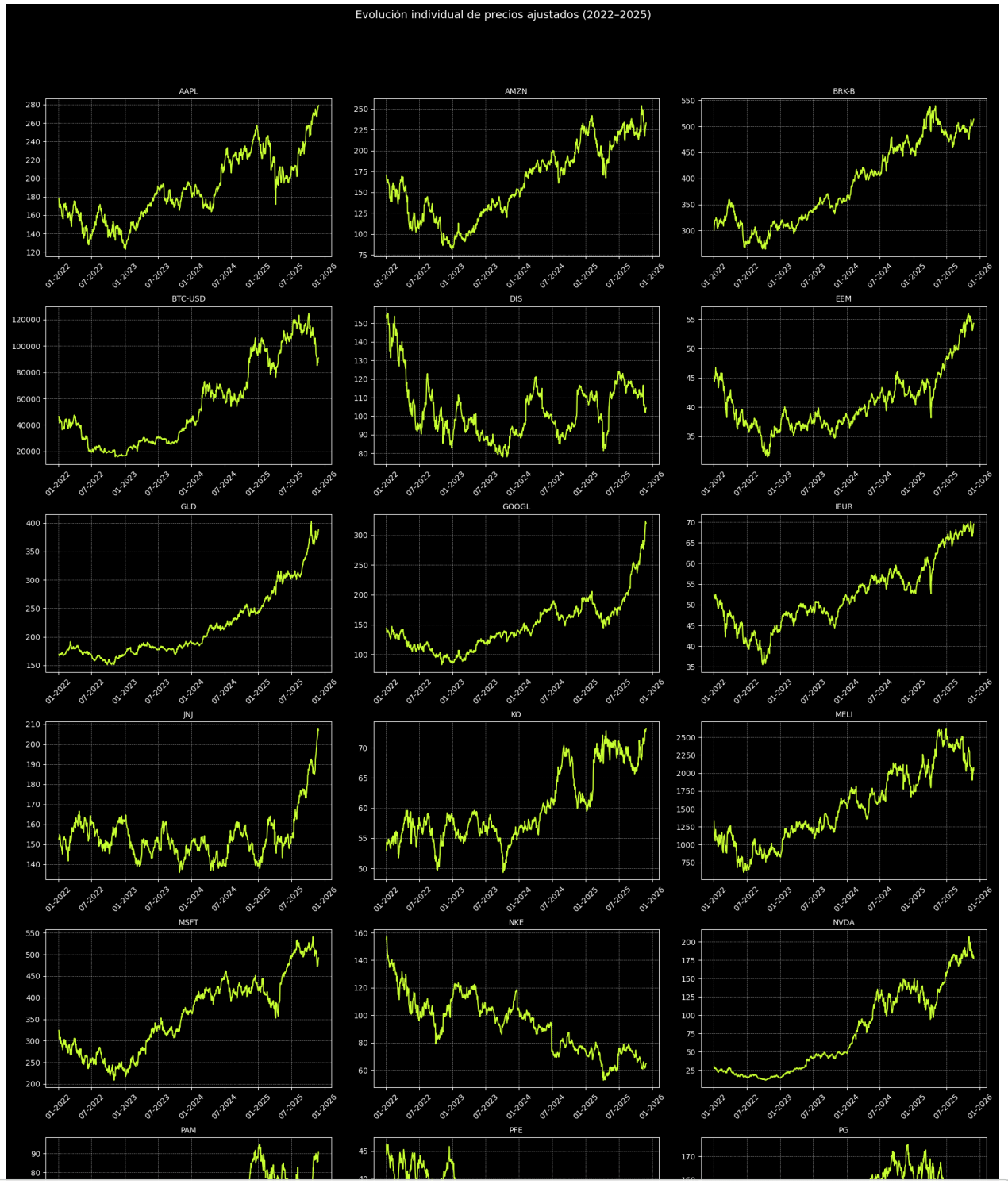
```
Dimensiones base100: (981, 23)
```

Ticker	AAPL	AMZN	BRK-B	BTC-USD	DIS	EEM	GLD	GOOGL	IEUR	JNJ
Date										
2022-01-03	100.000000	100.000000	100.000000	100.000000	100.000000	100.000000	100.000000	100.000000	100.000000	100.000000
2022-01-04	98.730828	98.308441	102.573221	98.793444	99.342947	99.654479	100.736652	99.591706	100.221542	99.731851
2022-01-05	96.104612	96.451091	103.035342	93.781252	98.998482	98.028465	100.433669	95.022822	99.386507	100.396429
2022-01-06	94.500307	95.803809	104.132449	92.902882	100.089313	98.475615	99.203947	95.003854	98.977514	100.052484
2022-01-07	94.593690	95.393024	106.313371	89.452403	100.682585	99.369925	99.655438	94.500033	99.505796	101.404922

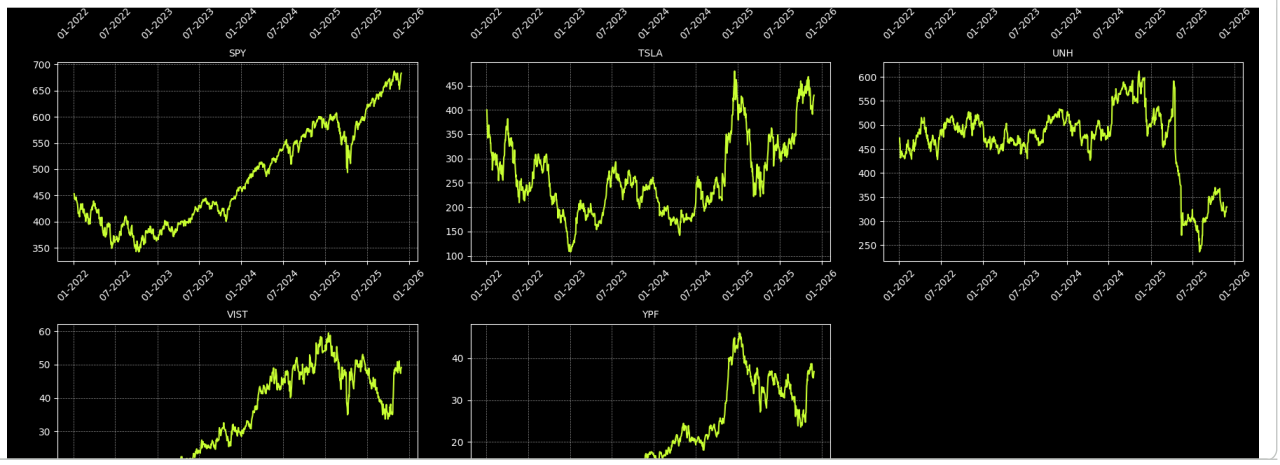
5 rows × 23 columns

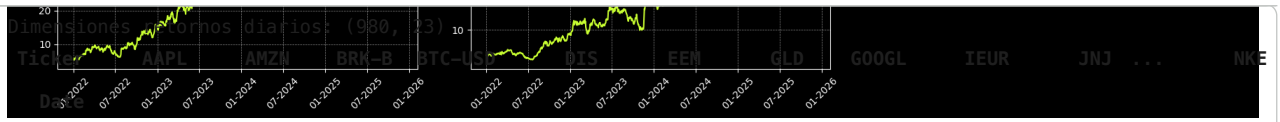



```
# Paso 7: Gráficos individuales de precios ajustados

import matplotlib.dates as mdates

n = len(data.columns)
cols = 3
rows = math.ceil(n / cols)

fig, axes = plt.subplots(nrows=rows, ncols=cols, figsize=(18, 4*rows), sharex=True)
axes = axes.flatten()

for i, ticker in enumerate(data.columns):
    axes[i].plot(data.index, data[ticker], lw=1.5, color="#ccff33")
    axes[i].set_title(ticker, fontsize=10)
    axes[i].tick_params(axis='x', labelbottom=True)
    axes[i].grid(True, color="#d3d3d3", linestyle="--", linewidth=0.5, alpha=0.7)

for j in range(i+1, len(axes)):
    fig.delaxes(axes[j])

date_format = mdates.DateFormatter('%m-%Y')
for ax in axes:
    ax.xaxis.set_major_formatter(date_format)
    ax.tick_params(axis='x', rotation=45)

plt.suptitle("Evolución individual de precios ajustados (2022-2025)", fontsize=14)
plt.tight_layout()
plt.subplots_adjust(top=0.93)
plt.show()
```




```
# Paso 8: Retornos diarios
ret_diarios = data.pct_change().dropna()
print("Dimensiones retornos diarios:", ret_diarios.shape)
display(ret_diarios.head())
```

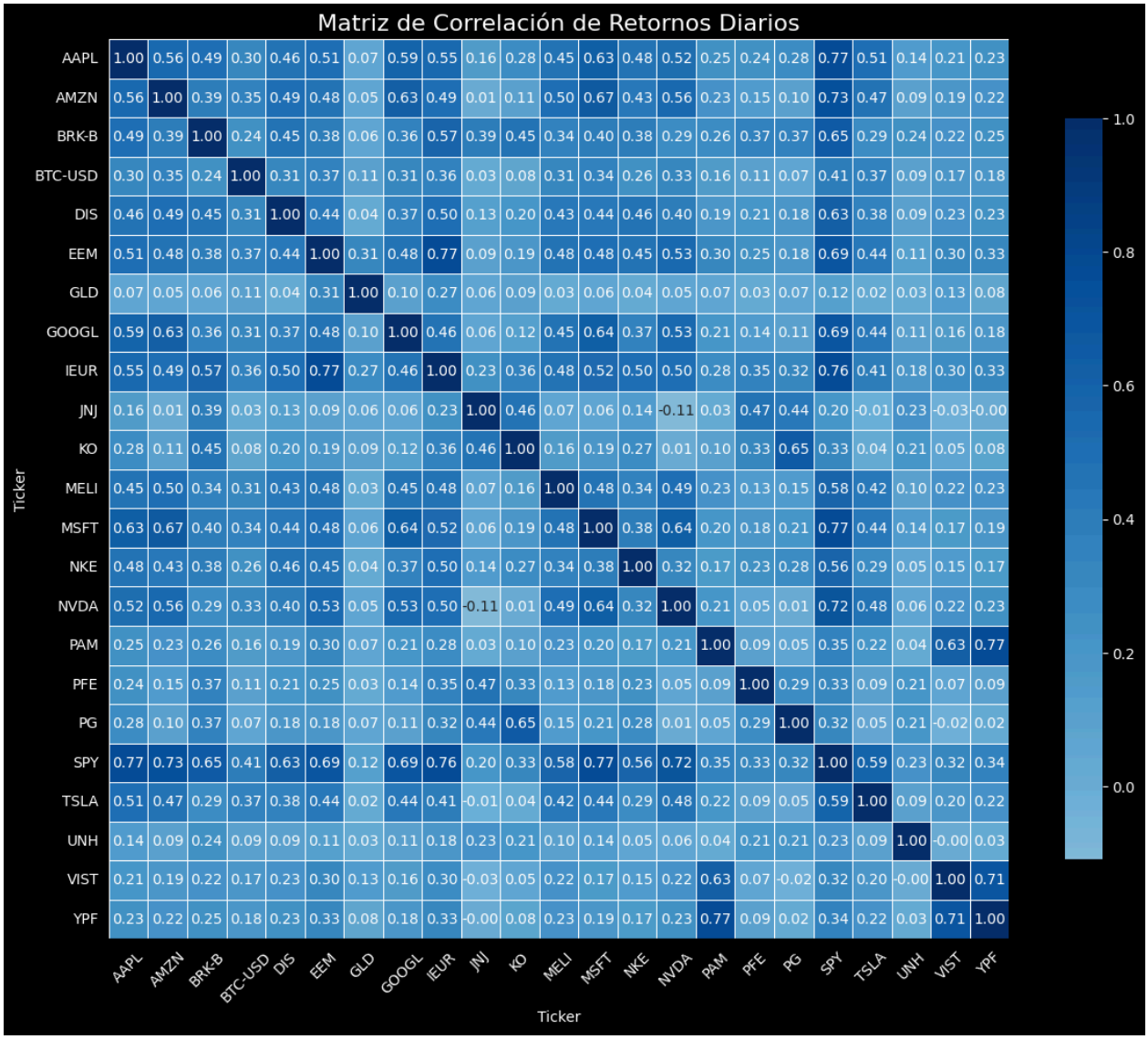




											...	
2022-01-04	-0.012692	-0.016916	0.025732	-0.012066	-0.006571	-0.003455	0.007367	-0.004083	0.002215	-0.002681	...	0.010445
2022-01-05	-0.026600	-0.018893	0.004505	-0.050734	-0.003467	-0.016317	-0.003008	-0.045876	-0.008332	0.006664	...	-0.024881
2022-01-06	-0.016693	-0.006711	0.010648	-0.009366	0.011019	0.004561	-0.012244	-0.000200	-0.004115	-0.003426	...	-0.007457
2022-01-07	0.000988	-0.004288	0.020944	-0.037141	0.005927	0.009082	0.004551	-0.005303	0.005337	0.013517	...	-0.025273
2022-01-10	0.000116	-0.006570	-0.002658	0.006337	-0.007793	0.000000	0.003040	0.012061	-0.012845	-0.004944	...	-0.041601

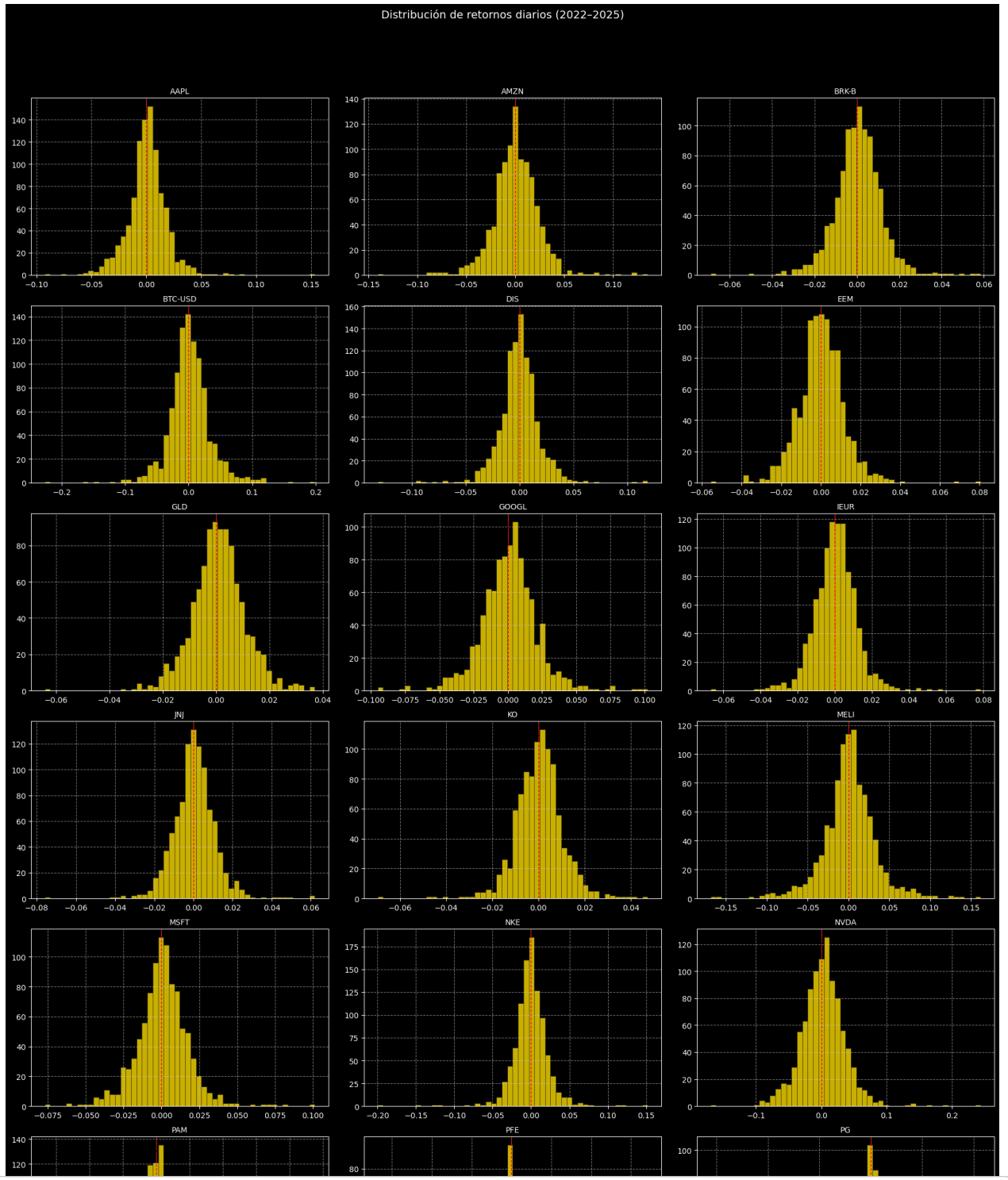
5 rows × 23 columns

```
# Paso 9: Matriz de correlaciones
correlacion = ret_diarios.corr()

plt.figure(figsize=(12, 10))
ax = sns.heatmap(
    correlacion,
    annot=True,
    cmap='Blues',
    center=0,
    linewidths=0.7,
    fmt=".2f",
    square=True,
    cbar_kws={"shrink": 0.8}
)

ax.grid(False)
ax.tick_params(left=False, bottom=False)

plt.title('Matriz de Correlación de Retornos Diarios', fontsize=16)
plt.xticks(rotation=45)
plt.yticks(rotation=0)
plt.tight_layout()
plt.show()
```



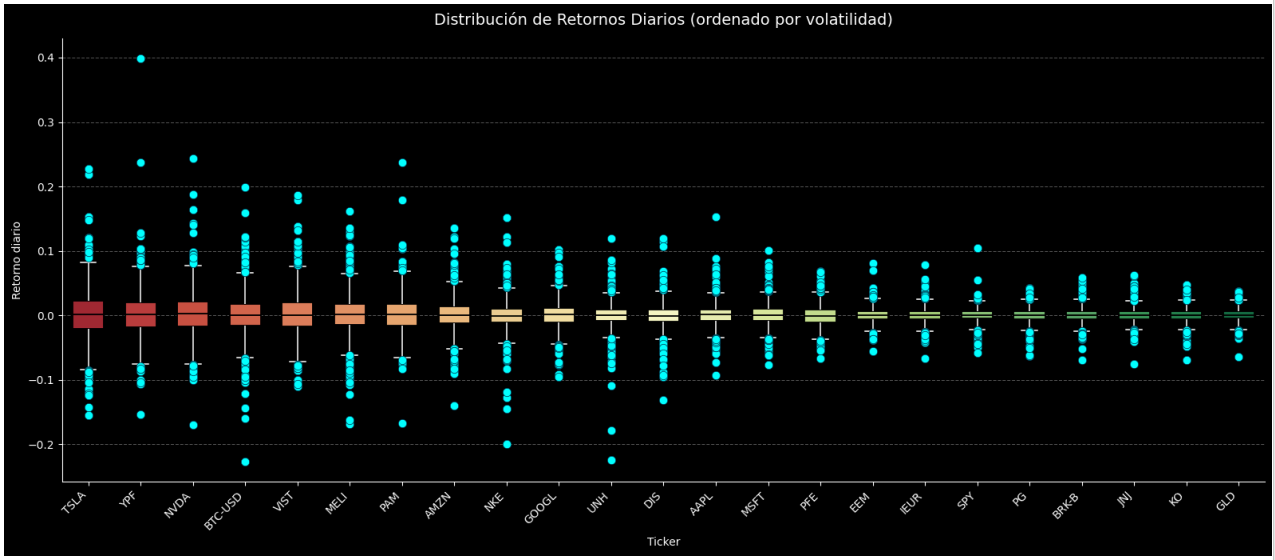

```
# Paso 10: Histogramas de retornos diarios

n = len(ret_diarios.columns)
cols = 3
rows = math.ceil(n / cols)

fig, axes = plt.subplots(rows, cols, figsize=(18, 4*rows))
axes = axes.flatten()

for i, ticker in enumerate(ret_diarios.columns):
    axes[i].hist(
        ret_diarios[ticker],
        bins=50,
        alpha=0.8,
        color="#ffdd00",
        edgecolor="#222222",
        linewidth=0.5
    )
    # Línea vertical en 0%
    axes[i].axvline(0, color="red", linestyle="--", linewidth=1)

    axes[i].set_title(ticker, fontsize=10)
    axes[i].grid(True, linestyle="--", color="#d3d3d3", alpha=0.6)

# Eliminar ejes vacíos
for j in range(i+1, len(axes)):
    fig.delaxes(axes[j])
```

```
plt.suptitle("Distribución de retornos diarios (2022–2025)", fontsize=14)
plt.tight_layout()
plt.subplots_adjust(top=0.93)
plt.show()
```




```
# Paso 11: Boxplots comparativos de retornos diarios

# Ordenar tickers por volatilidad (descendente)
order = ret_diarios.std().sort_values(ascending=False).index

# Paleta de color (de rojo a verde)
paleta = sns.color_palette("RdYlGn", n_colors=len(order))

plt.figure(figsize=(16, 7))

# Configuración de los outliers con contorno
flier_props = dict(
    marker='o',
    markerfacecolor='#00FFFF',   # relleno
    markeredgecolor='#00334d',   # contorno
    markeredgewidth=0.5,         # grosor del contorno
    markersize=7.5,
    alpha=1
)

# Propiedades visuales adicionales
box_props = dict(edgecolor='black', linewidth=1.3)     # borde de cada caja
median_props = dict(color='black', linewidth=1.3)      # línea mediana
```

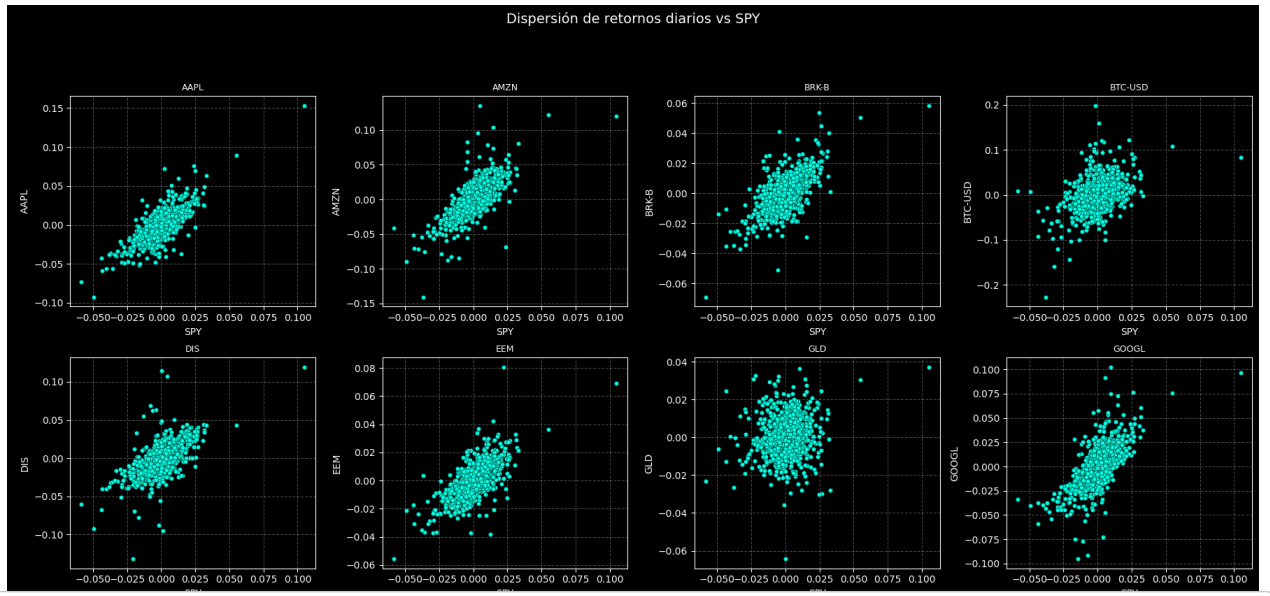
```
whisker_props = dict(color='white', linewidth=1.1)     # bigotes visibles
cap_props = dict(color='white', linewidth=1.1)         # extremos de los bigotes

# Crear el boxplot
sns.boxplot(
    data=ret_diarios[order],
    palette=paleta,
    showfliers=True,
    linewidth=1.3,
    width=0.6,
    flierprops=flier_props,
    boxprops=box_props,
    medianprops=median_props,
    whiskerprops=whisker_props,
    capprops=cap_props
)

sns.despine()
plt.title("Distribución de Retornos Diarios (ordenado por volatilidad)", fontsize=14, pad=12)
plt.ylabel("Retorno diario")
plt.xticks(rotation=45, ha="right")
plt.grid(axis="y", linestyle="--", alpha=0.35)
plt.tight_layout()
plt.show()
```



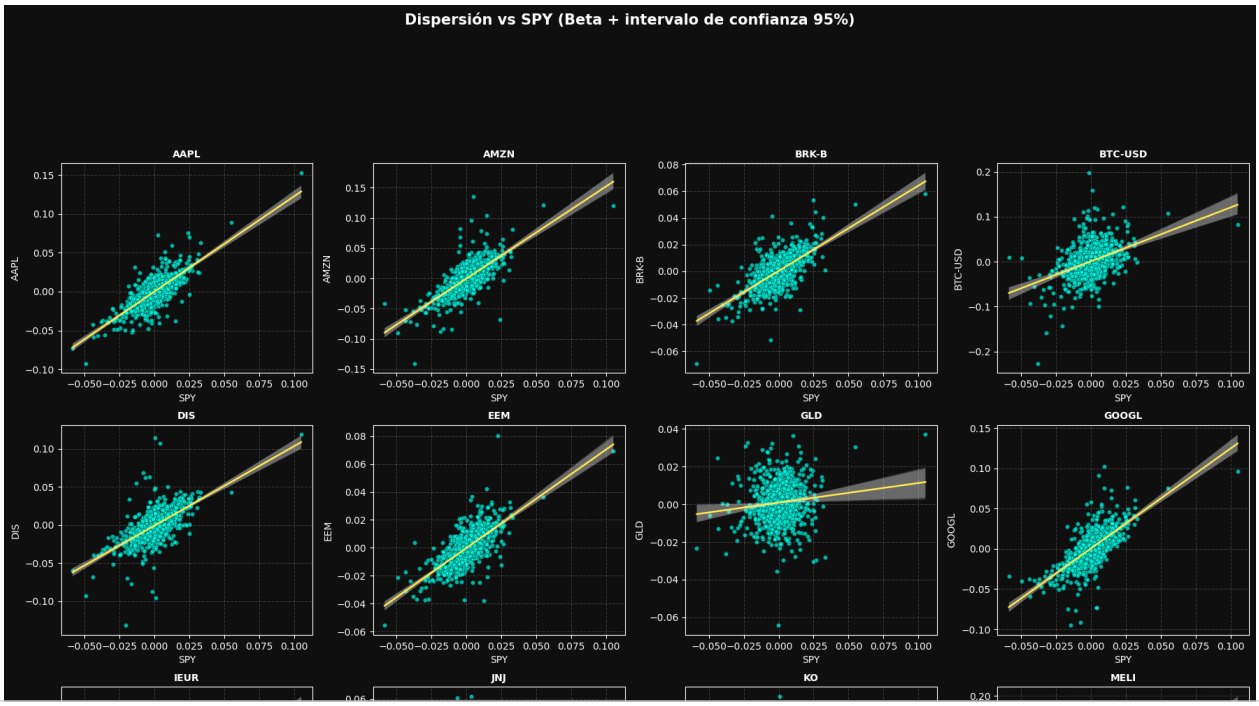

```
# Paso 12: Estadísticas descriptivas

# Básicas (diarias)
stats = ret_diarios.describe(percentiles=[.01,.05,.25,.5,.75,.95,.99]).T

# Métricas adicionales
stats["skew"] = ret_diarios.skew()
stats["kurt"] = ret_diarios.kurt()

# Anualizadas
stats["mean_ann"] = ret_diarios.mean() * 252
stats["vol_ann"]  = ret_diarios.std()  * np.sqrt(252)

# Ordenar por volatilidad anualizada
stats = stats.sort_values("vol_ann", ascending=False)

display(stats.round(4))
```

Ticker	count	mean	std	min	1%	5%	25%	50%	75%	95%	99%	max	skew	kurt	mean_
TSLA	980.0	0.0008	0.0392	-0.1543	-0.0974	-0.0615	-0.0207	0.0010	0.0221	0.0622	0.1011	0.2269	0.2911	2.8194	0.2
YPF	980.0	0.0029	0.0360	-0.1534	-0.0731	-0.0489	-0.0182	0.0014	0.0203	0.0630	0.0895	0.3989	1.7219	16.6787	0.7
NVDA	980.0	0.0024	0.0342	-0.1697	-0.0781	-0.0522	-0.0176	0.0030	0.0216	0.0529	0.0898	0.2437	0.5402	4.6781	0.6
BTC-USD	980.0	0.0012	0.0335	-0.2268	-0.0854	-0.0505	-0.0159	0.0004	0.0175	0.0555	0.0979	0.1987	0.0349	5.4983	0.3
VIST	980.0	0.0028	0.0330	-0.1098	-0.0781	-0.0493	-0.0170	0.0008	0.0208	0.0567	0.0979	0.1866	0.5641	2.6270	0.7
MELI	980.0	0.0010	0.0324	-0.1688	-0.0925	-0.0493	-0.0143	0.0011	0.0176	0.0513	0.0918	0.1616	-0.0411	3.5359	0.2
PAM	980.0	0.0020	0.0301	-0.1670	-0.0620	-0.0433	-0.0160	0.0011	0.0182	0.0477	0.0781	0.2375	0.7165	5.9076	0.5
AMZN	980.0	0.0006	0.0238	-0.1405	-0.0613	-0.0358	-0.0123	0.0004	0.0139	0.0358	0.0653	0.1354	0.1639	4.6563	0.1
NKE	980.0	-0.0006	0.0227	-0.1998	-0.0582	-0.0318	-0.0114	-0.0006	0.0105	0.0317	0.0602	0.1519	-0.5725	12.5371	-0.1
GOOGL	980.0	0.0010	0.0207	-0.0951	-0.0497	-0.0313	-0.0109	0.0014	0.0120	0.0318	0.0563	0.1022	0.0850	2.9255	0.2
UNH	980.0	-0.0002	0.0201	-0.2238	-0.0607	-0.0264	-0.0083	0.0006	0.0092	0.0250	0.0522	0.1198	-2.1078	24.9787	-0.0
DIS	980.0	-0.0002	0.0191	-0.1316	-0.0505	-0.0286	-0.0093	-0.0003	0.0095	0.0294	0.0449	0.1189	-0.0458	7.7154	-0.0
AAPL	980.0	0.0006	0.0181	-0.0925	-0.0481	-0.0291	-0.0082	0.0010	0.0096	0.0262	0.0455	0.1533	0.5422	7.2587	0.1
MSFT	980.0	0.0006	0.0170	-0.0772	-0.0423	-0.0268	-0.0080	0.0007	0.0098	0.0255	0.0428	0.1013	0.2497	3.3064	0.1
PFE	980.0	-0.0005	0.0157	-0.0672	-0.0399	-0.0237	-0.0102	-0.0008	0.0085	0.0262	0.0426	0.0683	0.2464	1.6661	-0.1
EEM	980.0	0.0003	0.0117	-0.0556	-0.0285	-0.0182	-0.0060	0.0005	0.0070	0.0181	0.0299	0.0805	0.4090	4.2452	0.0
IEUR	980.0	0.0004	0.0115	-0.0668	-0.0304	-0.0169	-0.0062	0.0007	0.0065	0.0171	0.0294	0.0785	0.2445	4.7634	0.0
SPY	980.0	0.0005	0.0114	-0.0585	-0.0322	-0.0171	-0.0051	0.0006	0.0064	0.0178	0.0264	0.1050	0.3614	9.0120	0.1
PG	980.0	0.0001	0.0113	-0.0623	-0.0277	-0.0176	-0.0058	0.0004	0.0066	0.0166	0.0284	0.0427	-0.4853	3.2657	0.0
BRK-B	980.0	0.0006	0.0112	-0.0691	-0.0282	-0.0169	-0.0055	0.0007	0.0070	0.0172	0.0292	0.0584	-0.0146	3.8880	0.1
JNJ	980.0	0.0004	0.0109	-0.0759	-0.0262	-0.0161	-0.0053	0.0004	0.0059	0.0161	0.0286	0.0619	0.1133	5.5538	0.0
KO	980.0	0.0004	0.0102	-0.0696	-0.0256	-0.0151	-0.0057	0.0006	0.0060	0.0164	0.0265	0.0473	-0.2652	4.1147	0.0

```
# Paso 13: Diagramas de dispersión de cada activo vs SPY

tickers = [t for t in ret_diarios.columns if t != "SPY"]

n = len(tickers)
cols = 4
rows = (n + cols - 1) // cols

fig, axes = plt.subplots(rows, cols, figsize=(18, 4*rows))
axes = axes.flatten()

for i, t in enumerate(tickers):
    ax = axes[i]
    ax.scatter(
        ret_diarios["SPY"],
        ret_diarios[t],
        s=20,                      # tamaño de los puntos
        alpha=1,                 # transparencia
        facecolors="#00ffe7",      # color de relleno
        edgecolors="#004d40",      # contorno oscuro
        linewidths=0.5             # grosor del contorno
    )
    ax.set_title(t, fontsize=9)
    ax.set_xlabel("SPY")
    ax.set_ylabel(t)
    ax.grid(True, color="#cccccc", linestyle="--", alpha=0.4)

# Quitar subplots vacíos
for j in range(i+1, len(axes)):
    fig.delaxes(axes[j])

plt.suptitle("Dispersión de retornos diarios vs SPY", fontsize=14)
plt.tight_layout()
plt.subplots_adjust(top=0.93)
plt.show()
```




```
# Paso 14: Dispersión vs SPY

tickers = [t for t in ret_diarios.columns if t != "SPY"]
n, cols = len(tickers), 4
rows = (n + cols - 1) // cols

fig, axes = plt.subplots(rows, cols, figsize=(18, 4*rows), facecolor="#111111")
axes = axes.flatten()

for i, t in enumerate(tickers):
    ax = axes[i]
    ax.set_facecolor("#111111")

    # Puntos de dispersión
    ax.scatter(
        ret_diarios["SPY"], ret_diarios[t],
        alpha=0.7,
        s=20,
        facecolors="#00FFE7",    # relleno turquesa brillante
        edgecolors="#003F3C",    # contorno verde petróleo oscuro
        linewidths=0.5
    )

    # Línea de regresión amarilla (Beta)
    sns.regplot(
        x=ret_diarios["SPY"], y=ret_diarios[t],
        scatter=False, ax=ax, color="#ffeb3b", ci=None,
        line_kws={"lw":1.8}
    )
# Intervalos de confianza (líneas blancas difusas)
    for _ in range(3):
        sns.regplot(
            x=ret_diarios["SPY"], y=ret_diarios[t],
            scatter=False, ax=ax, color="white", ci=95,
            line_kws={"lw": 0.5, "alpha": 0.15}
    )

    # Estilo de cada subplot
    ax.set_title(t, fontsize=10, fontweight="bold", color="white")
    ax.tick_params(colors="white")
    ax.xaxis.label.set_color("white")
    ax.yaxis.label.set_color("white")
    ax.grid(True, linestyle="--", alpha=0.2, color="white")

# Quitar subplots vacíos
for j in range(i+1, len(axes)):
    fig.delaxes(axes[j])

plt.suptitle("Dispersión vs SPY (Beta + intervalo de confianza 95%)",
             fontsize=15, fontweight="bold", color="white", y=1.02)
plt.tight_layout()
plt.subplots_adjust(top=0.93)
plt.show()
```




```
# Paso 15: Ratios Performance

retornos = ret_diarios.copy()
activos = [t for t in tickers if t != "SPY"]
benchmark = "SPY"

r  = retornos[activos + [benchmark]].dropna(how="any")
rm = r[benchmark]
ra = r[activos]

mu_anual  = ra.mean() * 252
vol_anual = ra.std()  * (252 ** 0.5)

rf_anual = 0.05
sharpe   = (mu_anual - rf_anual) / vol_anual

downside   = ra.where(ra < 0, 0.0)
down_vol_a = downside.std() * (252 ** 0.5)
sortino    = (mu_anual - rf_anual) / down_vol_a

var_mkt = np.var(rm, ddof=0)
betas = pd.Series({t: (np.cov(ra[t], rm, ddof=0)[0,1] / var_mkt) if var_mkt!=0 else np.nan for t in activos})

treynor = (mu_anual - rf_anual) / betas

ratios = (
    pd.DataFrame({
        "Sharpe": sharpe,
        "Sortino": sortino,
        "Treynor": treynor
    })
    .replace([np.inf, -np.inf], np.nan)
    .round(3)
    .sort_index()
)

ratios
```

Ticker	Sharpe	Sortino	Treynor
AAPL	0.369	0.626	0.087
AMZN	0.270	0.454	0.067
BRK-B	0.582	0.985	0.162
BTC-USD	0.497	0.842	0.219
DIS	-0.343	-0.549	-0.100
EEM	0.076	0.131	0.020
GLD	1.110	1.918	1.708
GOOGL	0.637	1.087	0.168
IEUR	0.217	0.369	0.052
JNJ	0.251	0.425	0.225
KO	0.284	0.470	0.156
MELI	0.381	0.627	0.119
MSFT	0.348	0.591	0.082
NKE	-0.581	-0.898	-0.187
NVDA	1.016	1.832	0.257
PAM	0.943	1.754	0.488
PFE	-0.678	-1.156	-0.375
PG	-0.182	-0.285	-0.105
TSLA	0.259	0.448	0.079
UNH	-0.282	-0.396	-0.226
VIST	1.253	2.382	0.720
YPF	1.183	2.355	0.626

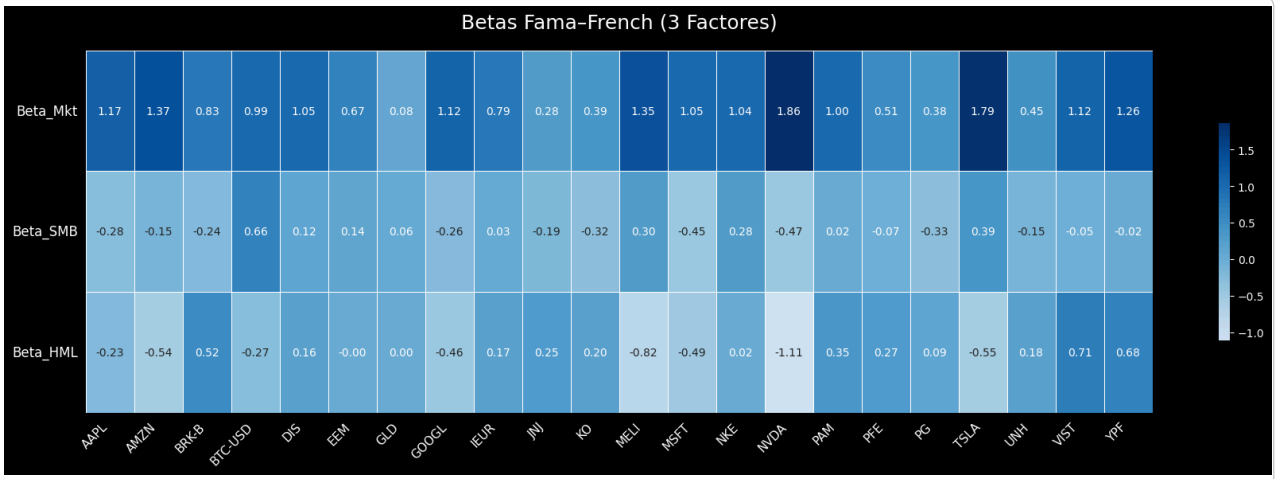
Próximos pasos: Generar código con ratios | New interactive sheet

```
# Paso 16: Implementación modelo Fama-French de 3 factores

# Descargar factores Fama-French (diarios)
url = "https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/ftp/F-F_Research_Data_Factors_daily_CSV.zip"
factors = pd.read_csv(url, skiprows=3)

factors = factors.rename(columns={"Unnamed: 0": "Date"})
factors = factors[factors["Date"].str.isnumeric()]
factors["Date"] = pd.to_datetime(factors["Date"], format="%Y%m%d")
factors = factors.set_index("Date").astype(float) / 100
factors = factors[["Mkt-RF", "SMB", "HML", "RF"]]

# Unión con retornos diarios (ajustar nombre de tu variable: ret_diarios)
data_ff = ret_diarios.join(factors, how="inner")

import statsmodels.api as sm

ff_results = {}
for ticker in [t for t in tickers if t != "SPY"]:  # todos menos SPY
    Ri = data_ff[ticker] - data_ff["RF"]
    X = data_ff[["Mkt-RF", "SMB", "HML"]]
    X = sm.add_constant(X)
    modelo = sm.OLS(Ri, X).fit()
    ff_results[ticker] = {
        "Alpha": round(modelo.params["const"], 4),
        "Beta_Mkt": round(modelo.params["Mkt-RF"], 4),
        "Beta_SMB": round(modelo.params["SMB"], 4),
        "Beta_HML": round(modelo.params["HML"], 4),
        "R2_ajustado": round(modelo.rsquared_adj, 4)
    }

ff_table = pd.DataFrame(ff_results).T.sort_index()
ff_table
```

	Alpha	Beta_Mkt	Beta_SMB	Beta_HML	R2_ajustado
AAPL	0.0000	1.1742	-0.2847	-0.2316	0.6072
AMZN	0.0001	1.3683	-0.1500	-0.5443	0.5893
BRK-B	0.0000	0.8262	-0.2429	0.5187	0.5980
BTC-USD	0.0012	0.9932	0.6647	-0.2659	0.2008
DIS	-0.0006	1.0483	0.1162	0.1607	0.4088
EEM	-0.0001	0.6676	0.1354	-0.0030	0.4979
GLD	0.0007	0.0798	0.0573	0.0036	0.0097
GOOGL	0.0004	1.1186	-0.2606	-0.4583	0.5130
IEUR	-0.0001	0.7889	0.0304	0.1654	0.5943
JNJ	-0.0000	0.2809	-0.1890	0.2515	0.0810
KO	-0.0001	0.3933	-0.3204	0.1991	0.1646
MELI	0.0007	1.3549	0.2995	-0.8185	0.4110
MSFT	0.0001	1.0472	-0.4451	-0.4927	0.6685
NKE	-0.0011	1.0415	0.2825	0.0152	0.3278
NVDA	0.0018	1.8642	-0.4664	-1.1104	0.5988
PAM	0.0015	1.0008	0.0199	0.3530	0.1302
PFE	-0.0009	0.5099	-0.0666	0.2683	0.1177
PG	-0.0003	0.3769	-0.3284	0.0889	0.1271
TSLA	0.0003	1.7855	0.3944	-0.5493	0.3873
UNH	-0.0005	0.4541	-0.1546	0.1807	0.0523
VIST	0.0022	1.1152	-0.0471	0.7129	0.1314
YPF	0.0023	1.2640	-0.0162	0.6824	0.1410

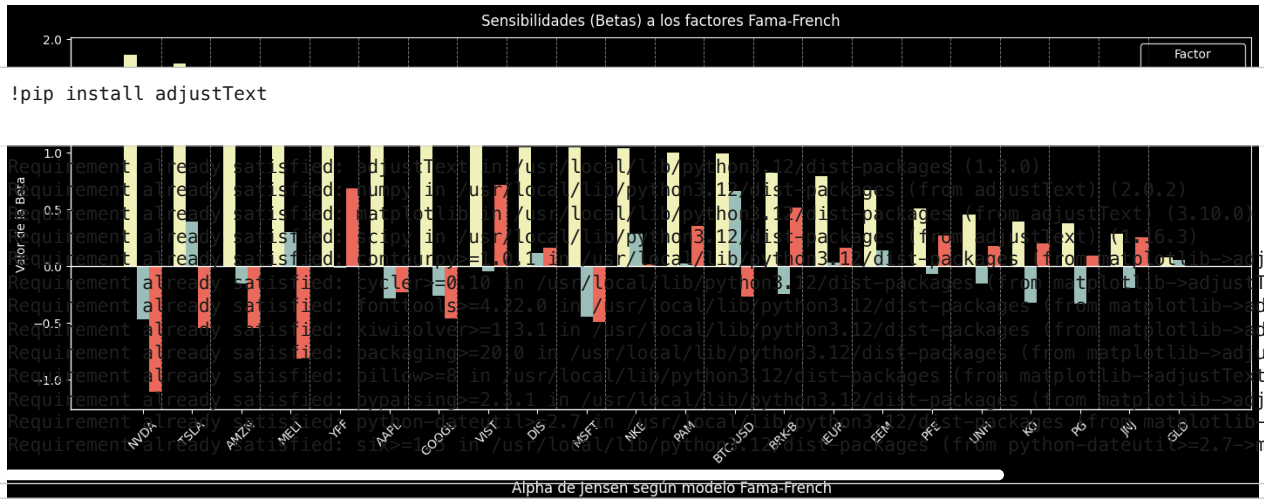
Próximos pasos: Generar código con ff_table | New interactive sheet

```
# Paso 17: Heatmap de betas

betas_ff = ff_table[["Beta_Mkt","Beta_SMB","Beta_HML"]]

plt.figure(figsize=(18, 6))
ax = sns.heatmap(
    betas_ff.T,
    annot=True,
    cmap='Blues',
    center=0,
    linewidths=0.7,
    fmt=".2f",
    cbar_kws={"shrink": 0.6}
)

ax.grid(False)
ax.tick_params(left=False, bottom=False, labelsize=11)

plt.title('Betas Fama-French (3 Factores)', fontsize=18, pad=20)
plt.xticks(rotation=45, ha="right", fontsize=11)
plt.yticks(rotation=0, fontsize=12)
plt.tight_layout()
plt.show()
```




```
# Paso 18: Visualización Betas, Alpha, R² ajustado

import matplotlib.colors as mcolors

# Betas
betas = ff_table[["Beta_Mkt", "Beta_SMB", "Beta_HML"]].sort_values("Beta_Mkt", ascending=False)

x = np.arange(len(betas.index))
width = 0.25
metrics = betas.columns
colors = ["#f4f1bb", "#9bc1bc", "#ed6a5a"]

plt.figure(figsize=(15, 6))
for i, metric in enumerate(metrics):
    plt.bar(x + i * width, betas[metric], width, label=metric, color=colors[i])

# Líneas divisorias verticales grises
for i in range(len(betas.index) - 1):
    xpos = x[i] + width * len(metrics)
    plt.axvline(x=xpos - width/2, color="gray", linestyle="--", linewidth=0.7)

# Estilo general
plt.xticks(x + width, betas.index, rotation=45, color="white")
plt.title("Sensibilidades (Betas) a los factores Fama-French", color="white", pad=10)
plt.ylabel("Valor de la Beta", color="white")
plt.legend(title="Factor", facecolor="black", edgecolor="white", labelcolor="white")
plt.grid(False)

# Eje X
ax = plt.gca()
ax.set_facecolor("#000000")
ax.spines["bottom"].set_color("white")
ax.spines["bottom"].set_linewidth(1)
ax.spines["left"].set_color("white")
ax.spines["left"].set_linewidth(1)
ax.tick_params(axis='x', colors='white')
ax.tick_params(axis='y', colors='white')

plt.axhline(0, color="white", linewidth=1.0)

plt.tight_layout(pad=3.0)
plt.show()



# Alpha
alpha_sorted = ff_table.sort_values("Alpha", ascending=False)["Alpha"]
colors = ["#48cae4" if v > 0 else "#caf0f8" for v in alpha_sorted]

plt.figure(figsize=(15,6))
```

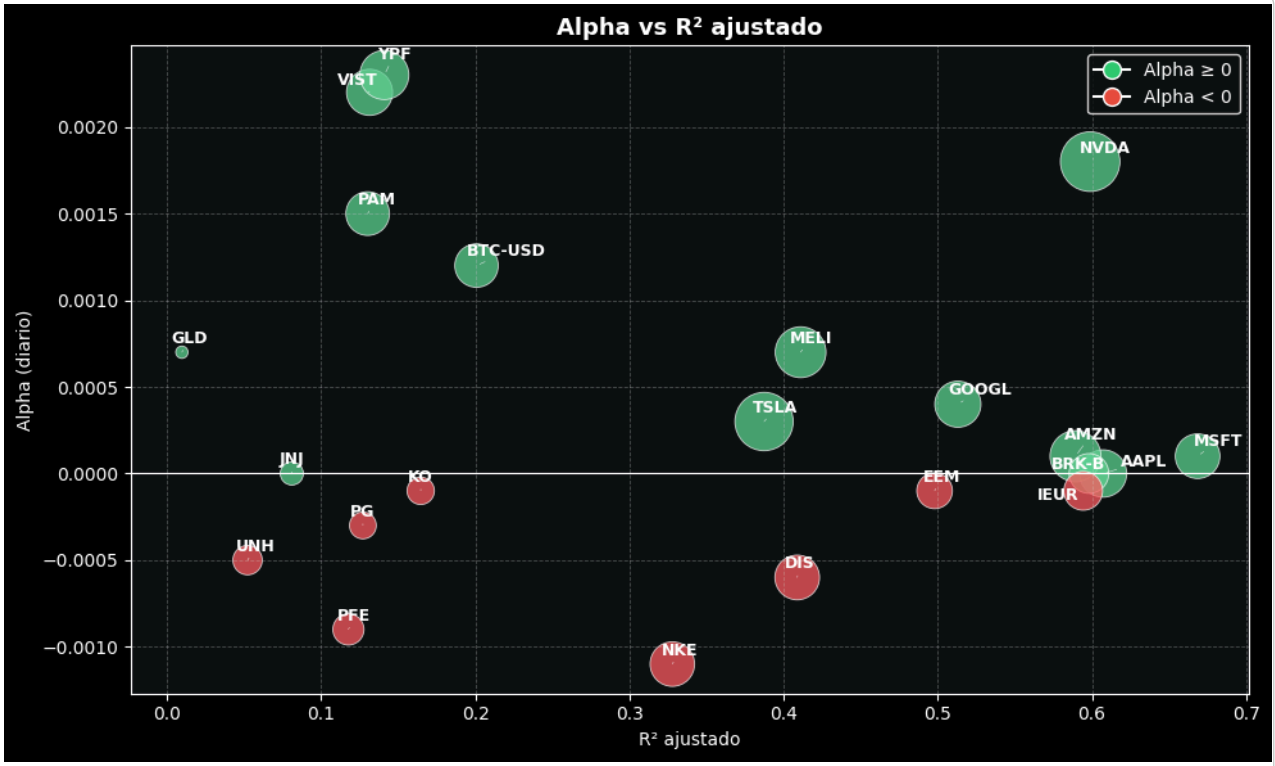
```
alpha_sorted.plot(kind="bar", color=colors)
plt.axhline(0, color="white", linewidth=0.8)
plt.title("Alpha de Jensen según modelo Fama-French", color="white")
plt.ylabel("Alpha (diario)", color="white")
plt.grid(False)

# Eje X
ax = plt.gca()
ax.set_facecolor("#000000")
ax.spines["bottom"].set_color("white")
ax.spines["bottom"].set_linewidth(1)
ax.tick_params(axis='x', colors='white')

plt.tight_layout(pad=3.0)
plt.show()


# R² Ajustado
r2_sorted = ff_table.sort_values("R2_ajustado", ascending=False)["R2_ajustado"]

cmap = mcolors.LinearSegmentedColormap.from_list("custom_violet", ["#e0c6ff", "#7400b8"])
norm = mcolors.Normalize(vmin=r2_sorted.min(), vmax=r2_sorted.max())
colors = [cmap(norm(v)) for v in r2_sorted]

plt.figure(figsize=(15,6))
r2_sorted.plot(kind="bar", color=colors)
plt.axhline(0, color="white", linewidth=0.8)
plt.title("R² ajustado de las regresiones Fama-French", color="white")
plt.ylabel("R² ajustado", color="white")
plt.grid(False)

# Eje X
ax = plt.gca()
ax.set_facecolor("#000000")
ax.spines["bottom"].set_color("white")
ax.spines["bottom"].set_linewidth(1)
ax.tick_params(axis='x', colors='white')

plt.tight_layout(pad=3.0)
plt.show()
```




```
!pip install adjustText
```



```
# Paso 19: Visualización Alpha vs R² ajustado (con etiquetas separadas)

from adjustText import adjust_text
from matplotlib.lines import Line2D

ff = ff_table.copy()
x = ff["R2_ajustado"]
y = ff["Alpha"]
s = (ff["Beta_Mkt"].abs() * 600).clip(30, 1200)

colors = np.where(y >= 0, "#60d394", "#ff5a5f")

plt.figure(figsize=(10,6))
plt.scatter(x, y, s=s, c=colors, alpha=0.75,
            edgecolors="white", linewidths=0.6)

# Crear etiquetas sin superposición
texts = []
for t in ff.index:
    texts.append(
        plt.text(
            x.loc[t], y.loc[t], t,
            fontsize=9, ha="center", va="bottom",
            color="white", fontweight="bold"
        )
    )

# Ajustar posiciones automáticamente
adjust_text(texts, arrowprops=dict(arrowstyle="-", color="white", lw=0.3))

# Línea horizontal en 0
plt.axhline(0, color="white", linewidth=0.8)

# Ejes y títulos
plt.xlabel("R² ajustado", color="white")
plt.ylabel("Alpha (diario)", color="white")
plt.title("Alpha vs R² ajustado", color="white", fontsize=13, fontweight="bold")

# Fondo oscuro
plt.gca().set_facecolor("#0d0f11")

# Leyenda
legend_elems = [
    Line2D([0],[0], marker='o', color='w', label='Alpha ≥ 0', markerfacecolor='#2ecc71', markersize=10),
    Line2D([0],[0], marker='o', color='w', label='Alpha < 0', markerfacecolor='#e74c3c', markersize=10)
]
plt.legend(handles=legend_elems, loc="best", facecolor="#0d0f11",
           edgecolor="white", labelcolor="white")

# Cuadrícula suave
plt.grid(True, linestyle="--", linewidth=0.6, alpha=0.35, color="#cccccc")

plt.tight_layout()
plt.show()
```

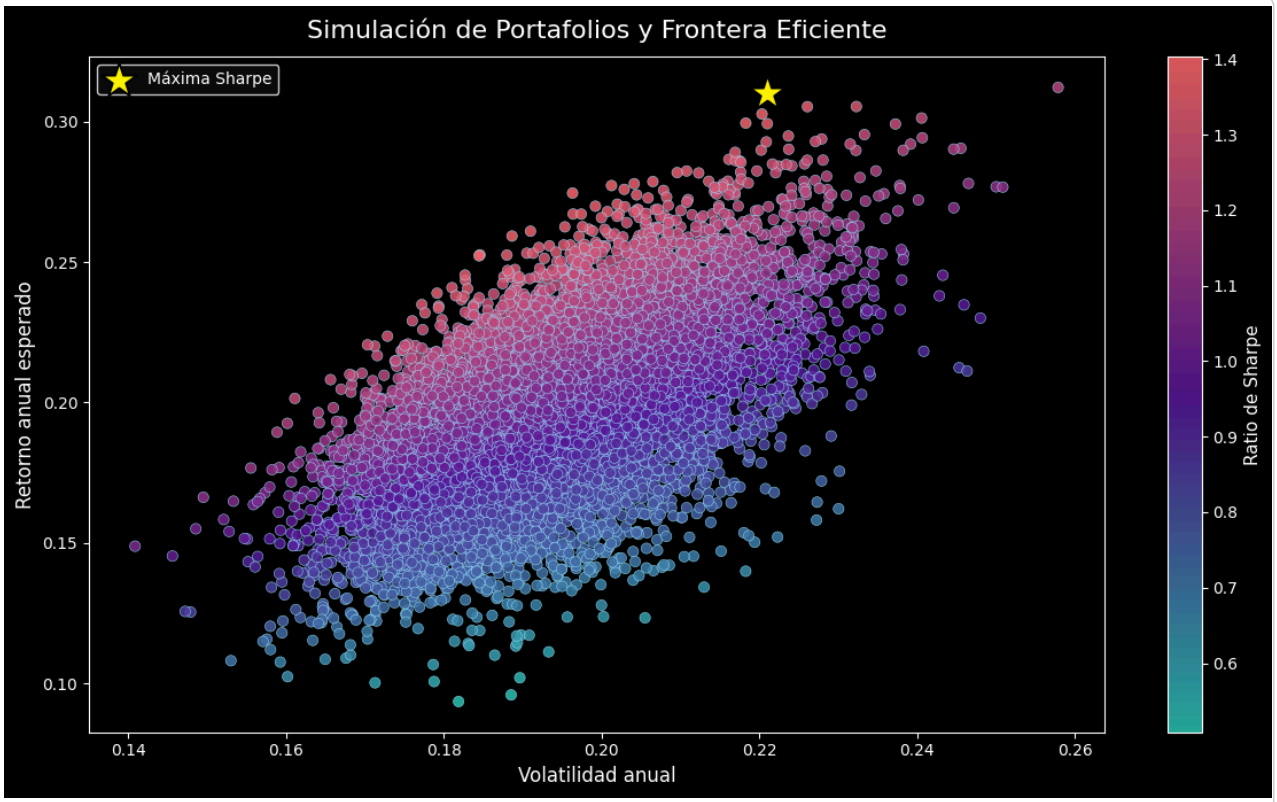



```
# Paso 20: Simulación Monte Carlo: generación de 10.000 portafolios aleatorios

# Universo y retornos diarios (excluye SPY)
activos = [t for t in tickers if t != "SPY"]
data_returns = ret_diarios[activos].dropna()

# Semilla y cantidad de simulaciones
np.random.seed(42)
num_portafolios = 10000

# Parámetros anualizados
media_retornos = data_returns.mean() * 252
matriz_cov     = data_returns.cov()  * 252
tickers_sim    = data_returns.columns

# Simulación de portafolios aleatorios
resultados = {"Retorno": [], "Volatilidad": [], "Sharpe": [], "Pesos": []}

for _ in range(num_portafolios):
    pesos = np.random.random(len(tickers_sim))
    pesos /= pesos.sum()

    retorno      = float(pesos @ media_retornos.values)
    volatilidad  = float(np.sqrt(pesos @ matriz_cov.values @ pesos))
    sharpe_ratio = retorno / volatilidad

    resultados["Retorno"].append(retorno)
    resultados["Volatilidad"].append(volatilidad)
    resultados["Sharpe"].append(sharpe_ratio)
    resultados["Pesos"].append(pesos)

# DataFrame de resultados
portafolios = pd.DataFrame(resultados)
portafolios["Pesos"] = portafolios["Pesos"].apply(lambda x: np.round(x, 4))

portafolios.head()
```

	Retorno	Volatilidad	Sharpe	Pesos
0	0.199462	0.209336	0.952834	[0.0378, 0.096, 0.0739, 0.0604, 0.0158, 0.0157...
1	0.177279	0.198857	0.891489	[0.0295, 0.037, 0.046, 0.0793, 0.0202, 0.0519,...
2	0.191760	0.190775	1.005164	[0.0237, 0.0607, 0.0286, 0.0477, 0.0501, 0.016...
3	0.261593	0.216959	1.205723	[0.0135, 0.0769, 0.0071, 0.0946, 0.074, 0.019,...
4	0.138644	0.181784	0.762684	[0.0889, 0.0473, 0.012, 0.0715, 0.0762, 0.0562...

Próximos pasos: Generar código con portafolios | New interactive sheet

```
# Paso 21: Visualización de la frontera eficiente y portafolio de máxima Sharpe

plt.style.use("dark_background")

# Identificar portafolio óptimo
idx_max_sharpe = portafolios["Sharpe"].idxmax()
mejor_portafolio = portafolios.loc[idx_max_sharpe]

plt.figure(figsize=(12, 7))

# Colormap
cmap = mpl.colors.LinearSegmentedColormap.from_list(
    "neo", ["#2ec4b6", "#5a189a", "#ff6b6b"]
)

# Nube de puntos
scatter = plt.scatter(
    portafolios["Volatilidad"], portafolios["Retorno"],
    c=portafolios["Sharpe"], cmap=cmap,
    alpha=0.85, s=45,
    edgecolors="#9be7ff", linewidths=0.4
)

# Barra de color
cbar = plt.colorbar(scatter)
cbar.set_label("Ratio de Sharpe", color="white", fontsize=11)
plt.setp(cbar.ax.get_yticklabels(), color="white")

# Portafolio óptimo (estrella dorada)
plt.scatter(
    mejor_portafolio["Volatilidad"], mejor_portafolio["Retorno"],
    color="#fcf300", marker="*", s=520, edgecolors="black", linewidths=1.3,
    label="Máxima Sharpe"
)

# Estética general
plt.title("Simulación de Portafolios y Frontera Eficiente", fontsize=16, color="white", pad=12)
plt.xlabel("Volatilidad anual", color="white", fontsize=12)
plt.ylabel("Retorno anual esperado", color="white", fontsize=12)
plt.legend(facecolor="#0D0F11", edgecolor="white")
plt.grid(False)

# Bordes del gráfico en blanco
ax = plt.gca()
for sp in ax.spines.values():
    sp.set_color("white")

plt.tight_layout()
plt.show()
```




```
# Paso 22: Métricas del portafolio óptimo (Máxima Sharpe)
metricas_optimas = mejor_portafolio[["Retorno", "Volatilidad", "Sharpe"]].copy()

# Formatear los valores
metricas_optimas["Retorno"] = f"{metricas_optimas['Retorno']*100:.2f}%"
metricas_optimas["Volatilidad"] = f"{metricas_optimas['Volatilidad']*100:.2f}%"
metricas_optimas["Sharpe"] = f"{metricas_optimas['Sharpe']:.2f}"

# Mostrar como Serie (vertical)
metricas_optimas = pd.Series(metricas_optimas)
metricas_optimas.name = "Métricas del Portafolio Óptimo"
display(metricas_optimas)
```

Métricas del Portafolio Óptimo	
Retorno	31.01%
Volatilidad	22.10%
Sharpe	1.40

dtype: object

```
# Paso 23: 10.000 carteras válidas con pisos y techos para PAM/YPF/VIST

activos = [t for t in tickers if t != "SPY"]
data_returns = ret_diarios[activos].dropna()

np.random.seed(42)
TARGET = 10_000
BATCH  = 50_000

media_retornos = data_returns.mean() * 252
matriz_cov     = data_returns.cov()  * 252
tickers_sim    = data_returns.columns


alpha = np.full(len(tickers_sim), 6.0)
limitados = ["YPF", "PAM", "VIST"]
idx_lim = [tickers_sim.get_loc(t) for t in limitados if t in tickers_sim]
for i in idx_lim:
```

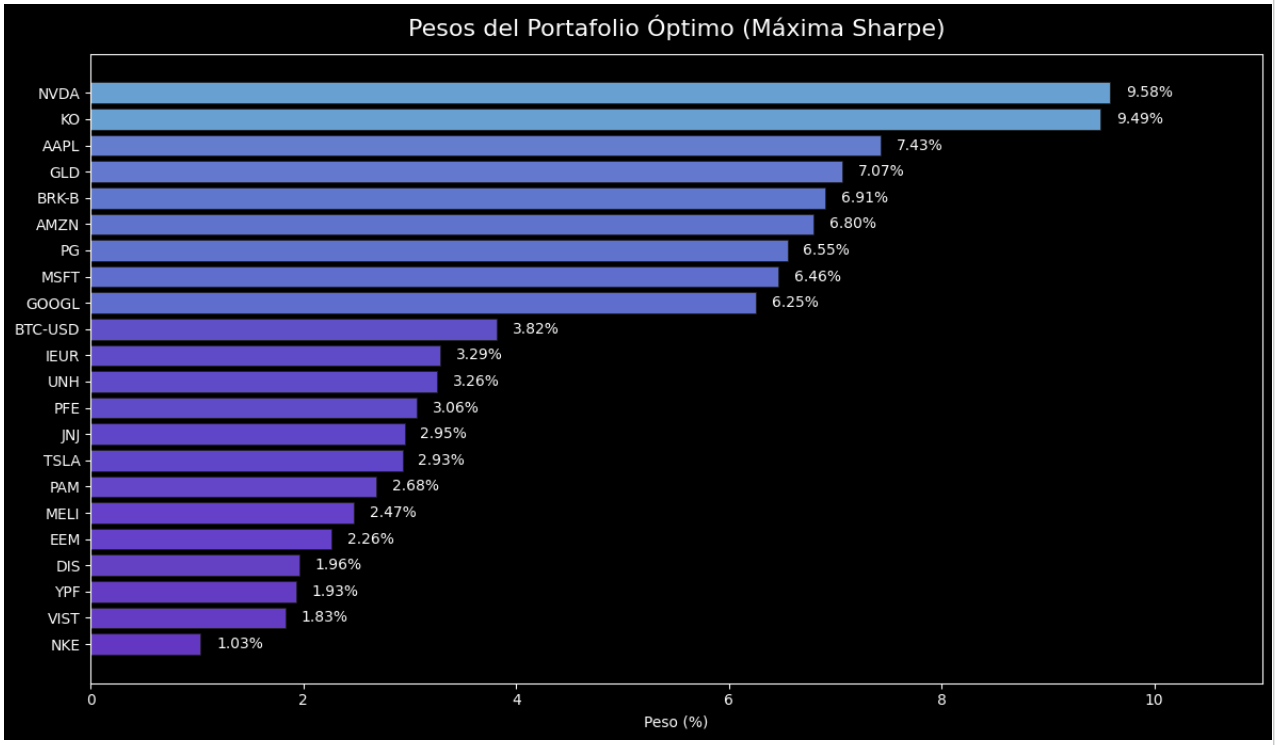
```
    alpha[i] = 2.0


floor = 0.018
cap   = 0.03

valid = []
total_gen = 0

while sum(len(v) for v in valid) < TARGET:
    W = np.random.dirichlet(alpha, size=BATCH)
    total_gen += BATCH
    ok = np.ones(len(W), dtype=bool)
    if idx_lim:
        ok &= (W[:, idx_lim] <= cap).all(axis=1)
        ok &= (W[:, idx_lim] >= floor).all(axis=1)
    valid.append(W[ok])

W_keep = np.vstack(valid)[:TARGET]
print(f"Generadas: {total_gen:,} | Aceptadas: {W_keep.shape[0]:,} | Tasa: {W_keep.shape[0]/total_gen:.1%}")

# Métricas vectorizadas
rets = W_keep @ media_retornos.values
vols = (np.einsum('ij,jk,ik->i', W_keep, matriz_cov.values, W_keep))**0.5
sharpes = rets / vols

portafolios = pd.DataFrame({"Retorno": rets, "Volatilidad": vols, "Sharpe": sharpes})
portafolios["Pesos"] = list(W_keep.round(4))

# Portafolio de máxima Sharpe
idx_max = portafolios["Sharpe"].idxmax()
mejor_portafolio = portafolios.loc[idx_max]

# Pesos óptimos (%)
pesos_optimos = pd.Series(mejor_portafolio["Pesos"], index=tickers_sim).sort_values(ascending=False)
pesos_optimos_pct = (pesos_optimos * 100).round(2).astype(str) + '%'
display(pesos_optimos_pct)
```

```
Generadas: 750,000 | Aceptadas: 10,000 | Tasa: 1.3%
```

Ticker	0
NVDA	9.58%
KO	9.49%
AAPL	7.43%
GLD	7.07%
BRK-B	6.91%
AMZN	6.8%
PG	6.55%
MSFT	6.46%
GOOGL	6.25%
BTC-USD	3.82%
IEUR	3.29%
UNH	3.26%
PFE	3.06%
JNJ	2.95%
TSLA	2.93%
PAM	2.68%
MELI	2.47%
EEM	2.26%
DIS	1.96%
YPF	1.93%
VIST	1.83%
NKE	1.03%

dtype: object

```
# Paso 24: Visualización de la composición del portafolio óptimo
plt.style.use("dark_background")

w = pd.Series(mejor_portafolio["Pesos"], index=tickers_sim).astype(float)
w_pct = (w * 100).round(2)
w_sorted = w_pct.sort_values(ascending=False)

cmap = mcolors.LinearSegmentedColormap.from_list("peso_grad", [(0.0,"#7400b8"),(0.5,"#5e60ce"),(1.0,"#80ffdb")])
norm = mcolors.Normalize(vmin=w_sorted.min() - 6, vmax=w_sorted.max() + 6)
colors = [cmap(norm(v)) for v in w_sorted[::-1]]

fig, ax = plt.subplots(figsize=(12,7))
ax.barh(w_sorted.index[::-1], w_sorted.values[::-1], color=colors, edgecolor="#222", linewidth=0.6)

ax.set_title("Pesos del Portafolio Óptimo (Máxima Sharpe)", fontsize=16, color="white", pad=12)
ax.set_xlabel("Peso (%)", color="white"); ax.set_ylabel("")
ax.tick_params(colors="white")
ax.grid(False)

for y, v in enumerate(w_sorted.values[::-1]):
    ax.text(v + 0.15, y, f"{v:.2f}%", va="center", color="white", fontsize=10)

ax.margins(x=0.15)
for sp in ax.spines.values(): sp.set_color("white")
plt.tight_layout(); plt.show()
```

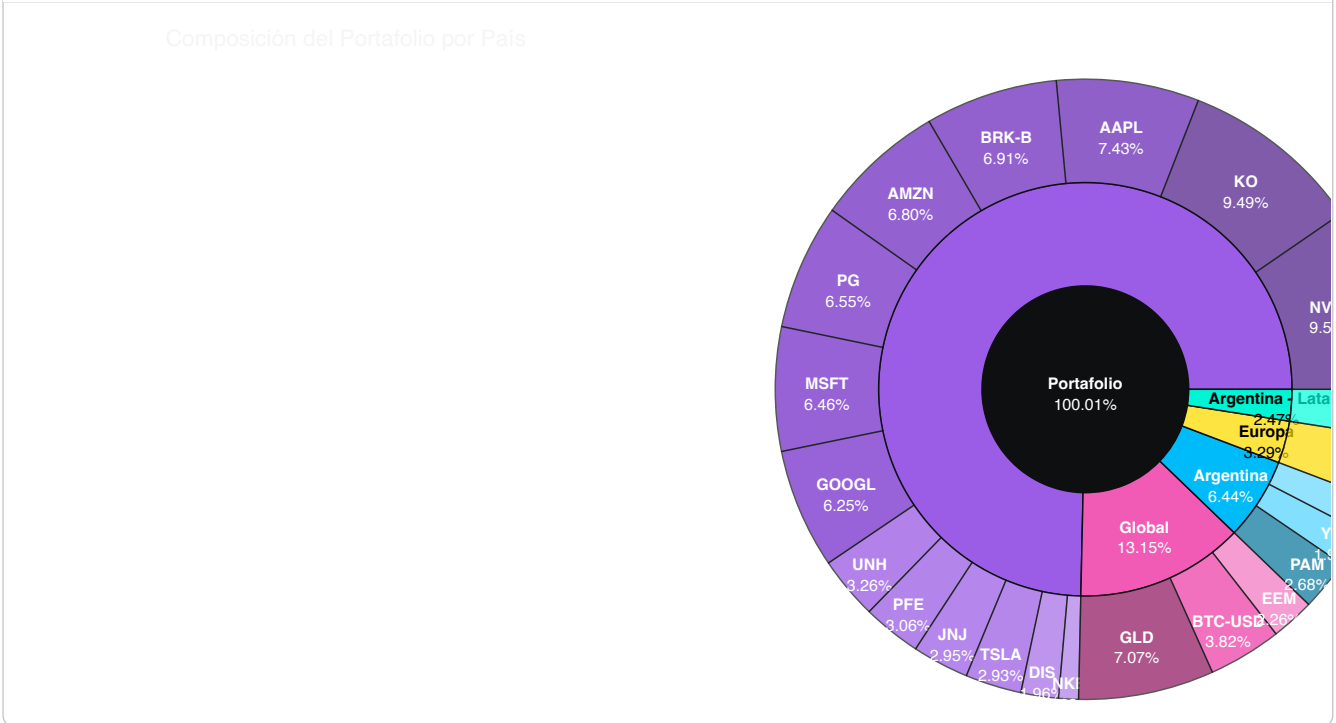



```
# Paso 25: construir df_pais desde el portafolio óptimo

# Pesos del portafolio óptimo (%)
w = pd.Series(mejor_portafolio["Pesos"], index=tickers_sim).astype(float)
w_pct = (w * 100).round(2)

# País por ticker
paises = {}
for t in w_pct.index:
    try:
        info = yf.Ticker(t).info
        paises[t] = info.get("country") or "Desconocido"
    except Exception:
        paises[t] = "Desconocido"

# ETFs/cripto
fallback_pais = {
```

```
    "GLD": "Global",
    "EEM": "Global",
    "IEUR": "Europa",
    "BTC-USD": "Global",
    "SPY": "United States"
}
for t, p in fallback_pais.items():
    if t in w_pct.index and (paises.get(t) in [None, "Desconocido", ""]):
        paises[t] = p

# Overrides manuales
overrides_pais = {
    "MELI": "Argentina - Latam",
    "VIST": "Argentina",
    "YPF": "Argentina",
    "PAM": "Argentina",
}
for t, p in overrides_pais.items():
    if t in w_pct.index:
        paises[t] = p

# DataFrame final para el sunburst
df_pais = (
    pd.DataFrame({"Ticker": w_pct.index, "Peso": w_pct.values})
      .assign(Pais=lambda d: d["Ticker"].map(paises).fillna("Desconocido"))
)
```

```
# Paso 26: Sunburst por país/sector

import colorsys
import plotly.graph_objects as go


# Paleta base por país
colores_pais = {
    "United States": "#9b5de5",
    "Global": "#f15bb5",
    "Europa": "#fee440",
    "Argentina": "#00bbf9",
    "Argentina - Latam": "#00f5d4",
    "Desconocido": "#dee2ff"
}

def hex_to_rgb(hexstr):
    hexstr = hexstr.lstrip("#")
    return tuple(int(hexstr[i:i+2], 16) for i in (0, 2, 4))

def rgb_to_hex(rgb):
    return "#%02x%02x%02x" % rgb

def shade_from_base(base_hex, t, darker_when_bigger=True):
    r, g, b = hex_to_rgb(base_hex)
    h, l, s = colorsys.rgb_to_hls(r/255.0, g/255.0, b/255.0)
    l_min, l_max = 0.30, 0.70
    L = l_max - t*(l_max - l_min) if darker_when_bigger else l_min + t*(l_max - l_min)
    R, G, B = colorsys.hls_to_rgb(h, L, s)
    return rgb_to_hex((int(R*255), int(G*255), int(B*255)))

# Jerarquía
root = "Portafolio"
labels  = [root]
parents = [""]
values  = [df_pais["Peso"].sum()]
colors  = ["#0d0f11"]

paises = df_pais["Pais"].unique().tolist()
peso_pais = df_pais.groupby("Pais")["Peso"].sum()

# Países
for p in paises:
    labels.append(p)
    parents.append(root)
    values.append(float(peso_pais.loc[p]))
    colors.append(colores_pais.get(p, "#4cc9f0"))

# Tickers con degradé dentro de cada país
for p in paises:
    base = colores_pais.get(p, "#4cc9f0")
    dfp = df_pais[df_pais["Pais"] == p].copy().sort_values("Peso", ascending=False)
    v = dfp["Peso"].values
    t_norm = (v - v.min()) / (v.max() - v.min()) if v.max() != v.min() else [0.5]*len(v)
```

```
        for (tick, peso, t) in zip(dfp["Ticker"], dfp["Peso"], t_norm):
            labels.append(tick)
            parents.append(p)
            values.append(float(peso))
            colors.append(shade_from_base(base, t, darker_when_bigger=True))

    # Figura
    fig = go.Figure(go.Sunburst(
        labels=labels,
        parents=parents,
        values=values,
        branchvalues="total",
        marker=dict(colors=colors, line=dict(color="rgba(13,15,17,1)", width=1.1)),
        textinfo="label+value+percent parent",
        texttemplate="<b>%{label}</b><br>%{value:.2f}%",
        textfont=dict(color="white", size=12),
        hovertemplate="<b>%{label}</b><br>Peso: %{value:.2f}%<br>Del país: %{percentParent:.1%}<extra></extra>",
    ))

    # Texto negro para sectores claros (Europa, IEUR, Argentina-Latam, MELI)
    sectores_claros = ["Europa", "IEUR", "Argentina - Latam", "MELI"]
    fig.update_traces(
        selector=dict(type="sunburst"),
        textfont=dict(
            color=[
                "black" if any(k.lower() in l.lower() for k in sectores_claros) else "white"
                for l in labels
            ],
            size=12
        )
    )

    fig.update_layout(
        title="Composición del Portafolio por País",
        paper_bgcolor="#0d0f11",
        plot_bgcolor="#0d0f11",
        font=dict(color="#f5f5f5", family="Orbitron, sans-serif"),
        margin=dict(l=10, r=10, t=50, b=10)
    )

    fig.show()
```




```
    # Paso 27: Treemap por país/sector

    import plotly.express as px

    # Pesos del óptimo (%)
    w = pd.Series(mejor_portafolio["Pesos"], index=tickers_sim).astype(float)
    w_pct = (w * 100).round(2)
```

```
# Datos desde Yahoo Finance (sector)
sectores = {}
for t in tickers_sim:
    try:
        info = yf.Ticker(t).info
        sectores[t] = info.get("sector") or "Desconocido"
    except Exception:
        sectores[t] = "Desconocido"

# Fallbacks
fallback_sector = {
    "GLD":"ETF/Commodity", "EEM":"ETF/Emergentes",
    "IEUR":"ETF/Europa", "BTC-USD":"Cripto"
}
for t, s in fallback_sector.items():
    if t in sectores and sectores[t] in [None, "Desconocido", ""]:
        sectores[t] = s

# DataFrame
df_sec = (
    pd.DataFrame({"Ticker": w_pct.index, "Peso": w_pct.values})
      .assign(Sector=lambda d: d["Ticker"].map(sectores).fillna("Desconocido"))
)

# Treemap
fig_treemap_sector = px.treemap(
    df_sec,
    path=["Sector","Ticker"], values="Peso", color="Peso",
    color_continuous_scale=["#7400b8","#5e60ce","#64dfdf","#80ffdb"],
    template="plotly_dark",
    title="Composición por Sector"
)

# Etiquetas
fig_treemap_sector.update_traces(
    texttemplate="%{label}<br>%{value:.2f}%",
    textfont_size=14,
    textfont_color="white"
)

# Cambiar solo NVDA a texto negro
for trace in fig_treemap_sector.data:
    if hasattr(trace, "labels"):
        new_colors = ["white"] * len(trace.labels)
        for i, label in enumerate(trace.labels):
            if label in ["NVDA", "Technology", "Information Technology"]:
                new_colors[i] = "black"
        trace.textfont = dict(color=new_colors)

fig_treemap_sector.update_layout(margin=dict(l=10, r=10, t=40, b=10))
fig_treemap_sector.show()
```