```
import os, math
import numpy as np, pandas as pd, matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.pipeline import Pipeline
from sklearn.preprocessing import StandardScaler, PolynomialFeatures
from sklearn.ensemble import RandomForestRegressor
from sklearn.linear_model import LinearRegression
from sklearn.metrics import r2_score, mean_absolute_error, mean_squared_error
```

```
df = pd.read_csv("china_gdp.csv")
print(df.head())
```

```
   Year         Value
0  1960  5.918412e+10
1  1961  4.955705e+10
2  1962  4.668518e+10
3  1963  5.009730e+10
4  1964  5.906225e+10
```

```
target = "Value"    # change to your GDP column name (e.g., "GDP", "value", "gdp")
X = df[["Year"]]    # predictor feature
y = df[target]
```

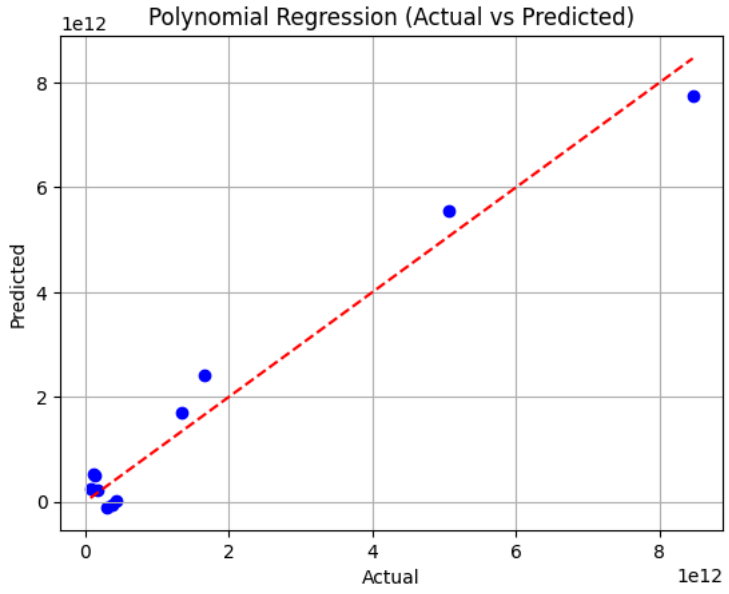
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
```

```
def metrics(y, yp, name):
    r2 = r2_score(y, yp); mae = mean_absolute_error(y, yp); rmse = math.sqrt(mean_squared_error(y, yp))
    print(f"{name} → R²={r2:.4f}, MAE={mae:.2f}, RMSE={rmse:.2f}")

def plot_actual_pred(y, yp, title):
    plt.scatter(y, yp, color='blue'); plt.plot([y.min(), y.max()], [y.min(), y.max()], 'r--')
    plt.xlabel("Actual"); plt.ylabel("Predicted"); plt.title(title); plt.grid(True); plt.show()
```

```
poly = Pipeline([('scale', StandardScaler()), ('poly', PolynomialFeatures(degree=3)), ('lr', LinearRegression())])
poly.fit(X_train, y_train)
yp_poly = poly.predict(X_test)
metrics(y_test, yp_poly, "Polynomial Regression")
plot_actual_pred(y_test, yp_poly, "Polynomial Regression (Actual vs Predicted)")
```

```
Polynomial Regression → R²=0.9679, MAE=416882058049.40, RMSE=459551729896.31
```




```
rf = RandomForestRegressor(n_estimators=100, random_state=42)
rf.fit(X_train, y_train)
yp_rf = rf.predict(X_test)
metrics(y_test, yp_rf, "Random Forest Regression")
plot_actual_pred(y_test, yp_rf, "Random Forest (Actual vs Predicted)")
```

```
Random Forest Regression → R²=0.9970, MAE=62627758968.46, RMSE=140589211263.33
```